# Nuclear Science Abstracts

Covering the Literature on Atomic Energy

Physics

Vol. 5, No. 3

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# NUCLEAR SCIENCE ABSTRACTS

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| NYO-503 | First Regular Annual Progress Report for July 1, 1949 - April 1, 1950. W. W. Watson. | 653 |
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| NYO-1514 | Final Report, Alpha Gamma Proportional Counter Feasibility Study. General Electric Co. | 659 |
| NYO-1525 | High Efficiency Collection of Radioactive Dust. K. J. Caplan. | 525 |
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| ORNL-782 | Quarterly Progress Report for Period Ending June 15, 1950; Physics Division. A. H. Snell and E. O. Wollan. | 618 |
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| ORNL-803 | The Preparation and Properties of Mammalian Ribonucleic Acids. E. Volkin and C. E. Carter. | 509 |
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| UCLA-98 | Exploratory Studies on a New General Synthesis of Straight-Chain Mono-Enoic Fatty Acids. H. M. Walborsky and D. R. Howton. | 586 |
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| UCRL-979 | Grain Density Measurements in Nuclear Emulsions. J. K. Bowker, J. R. Green, and W. H. Barkas. | 663 |
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### OTHER UNCLASSIFIED REPORTS OF SPECIAL INTEREST TO AEC LABORATORIES


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| AERE-C/R-582 | The Practical Characteristics of the Alpha-Electroscope No. 1096. C. J. Mandleberg. | 674 |
| AERE-G/R-565 | A Refrigerator-Cooled Two-Inch Diffusion Pump. R. S. Barton. | 601 |
| NRC-2026 | Shipping, Storage, and Handling of Cobalt 60. K. J. Parry. | 529 |
| USGS-TEI-120 | An Improved Fluorimeter for the Determination of Uranium in Fluoride Melts. M. H. Fletcher and I. May. | 570 |

# GENERAL

## ATOMIC BOMBS AND WARFARE

506

ATOMIC BOMB EFFECTS AND THE FIRE FIGHTER. Edward J. Kehoe and Francis L. Brannigan. Firemen 17, No. 11, 8-10(1950) Nov.

Ideas on fire defenses are derived from considerations of former atomic bomb bursts. Dispersal of some municipal fire apparatus to the outskirts, and mobile radio-equipped headquarters are some of the indicated measures.

## ATOMIC POWER

507

NUCLEAR ENERGY FOR POWER PRODUCTION. Ward F. Davidson. Atomics (London) 1, 320-27(1950) Nov.

In this paper, read before the Fourth World Power Conference, the general engineering problems needing solution before nuclear power can be practicable are discussed. Materials, heat transfer, neutron economy, control, and shielding are briefly considered.

508

RESISTANCE TO INNOVATION: THE CASE OF ATOMIC POWER. Vincent Heath Whitney. Am. J. Sociol. 56, 247-54(1950) Nov.

The development of peacetime uses of nuclear energy will not be automatic, nor is it likely to produce short-run revolutionary consequences. Like other major technological innovations, atomic power may meet with strong resistances, the strength and character of which will reflect to a considerable degree the patterns of cultural organization in various regions modified by the local demographic, ecological, and psychological conditions. The understanding of an invention is not to be equated with its use. (auth)

# BIOLOGY AND MEDICINE

509

Oak Ridge National Laboratory, Biology Division
THE PREPARATION AND PROPERTIES OF MAMMALIAN RIBONUCLEIC ACIDS. E. Volkin and C. E. Carter. Oct. 12, 1950. 18p. (ORNL-803)

A method for the preparation of mammalian ribonucleic acids employing high concentrations of guanidine hydrochloride in the fractionation procedure is reported. Mammalian ribonucleic acids are characterized with respect to mononucleotide analytical composition as well as nitrogen and phosphorus content. The extent of liberation of titratable phosphate groups by ribonuclease is determined. Preliminary experiments with the analytical ultracentrifuge reveal that the nucleic acid preparations exist essentially as single sedimenting boundaries.

510

Oak Ridge National Laboratory
YEAST MUTANTS REQUIRING PURINES AND PYRIMIDINES. Seymour Pomper. Nov. 3, 1950. 36p. (ORNL-812)

Mutant strains of Saccharomyces cerevisiae which required purines or pyrimidines for growth have been studied. No purines other than adenine and hypoxanthine, and none of the nucleosides or nucleotides tested, were able to support the growth of the purine-requiring mutants. Inhibition and stimulation by guanine, which was itself unutilizable, have been noted. Genetic analysis permits a tentative arrangement of the purineless mutants relative to a pigment-accumulating strain. Two were shown to precede and one to follow the pink mutant. Of all the compounds tested with the pyrimidineless yeast mutants, only uracil, cytosine, 5-nitrouracil, uridine, and uridylic acid had any growth-promoting activity. The rates of utilization and effectiveness of these compounds in supporting growth have been compared, and it was found that the free bases were used at least as efficiently and somewhat faster than the nucleosides or nucleotides. A brief comparison of these data with some from other microorganisms and tissues has been presented. (auth)

511

Oak Ridge National Laboratory
THE PREPARATION OF DESOXYNUCLEOTIDES. E. Volkin, J. X. Khym, and W. E. Cohn. Nov. 7, 1950. 22p. (ORNL-843)

Desoxynucleotides have been isolated in good yield from enzyme digests of desoxyribonucleic acid by the method of ion-exchange chromatography. The techniques of enzymatic digestion, ion-exchange separation of the mononucleotides, and the preparation of these as solid products are de-

scribed. The mononucleotides have been analyzed spectrophotometrically and with respect to nitrogen and phosphorus composition; some preliminary biological characterizations of these products have been carried out. (auth)

## RADIATION EFFECTS

512

Brookhaven National Laboratory and Harvard University
DIFFERENTIAL REJOINING AS A FACTOR IN APPARENT SENSITIVITY OF CHROMOSOMES TO X-RAY BREAKAGE. Arnold H. Sparrow and Marc Maldawer. [nd.] 14p. (AECU-989)

Differential rejoining has been studied in microspores of Trillium erectum following x irradiation at stages of high and low apparent sensitivity to breakage. The stages irradiated were meiotic first metaphase and early postmeiotic interphase. Fragments, dicentrics, and rings were scored at microspore anaphase. The numbers of dicentrics and rings observed were used as a measure of rejoining. The data indicate a significantly higher amount of rejoining in cells irradiated at early interphase than in those irradiated at meiotic metaphase. However, the increase in rejoining is not sufficient to account for the observed decrease in fragmentation. It is, therefore, concluded that the observed difference in sensitivity of the two stages studied is due in part to a difference in number of primary breaks (or potential breaks) and in part to a difference in the amount of rejoining which subsequently occurs. In the material studied a high sensitivity to primary breakage is associated with a low frequency of rejoining and vice versa. Certain implications of these conclusions on calculations of mutation rate and gene size are discussed. (auth)

513

University of Chicago Metallurgical Laboratory
METHODS OF EXPOSURE OF ANIMALS TO X RAYS. Charles W. Hagen, Jr., and Raymond E. Zirkle. Sept. 1950. 11p. (CH-3901)

Nothing new is added to methods of exposure to ionizing radiations by this paper. Its purpose is to provide a complete account of the methods used in the University of Chicago Metallurgical Laboratory and thus to eliminate unnecessary future repetition in papers on x-ray effects. The 200-kvp x-ray apparatus is described. The beam could be directed either horizontally or vertically. Animals were exposed in special boxes constructed of cellulose acetate or cellulose acetate–butyrate sheets centered in the field on an adjustable wood and canvas rack. Dosimetry techniques and average dosage rates for the various species are given.

514

University of Chicago Metallurgical Laboratory
COMPARATIVE BIOLOGICAL ACTIONS OF CYCLOTRON FAST NEUTRONS AND X RAYS; I. LETHAL ACTION ON MICE AND RABBITS. Charles W. Hagen, Jr., and Raymond E. Zirkle. Nov. 1950. 26p. (CH-3903)

X-irradiated rabbits exhibited three distinct periods of mortality: (1) "one-day" mortality, the fraction of the total number of animals that died in the first 3 days following irradiation; (2) "ten-day" mortality, the fraction of those rabbits alive at the end of 3 days which died by the 20th day; (3) "late" mortality, the fraction of those rabbits alive at the 20th day which died on subsequent days. In the first period, weight and sex had considerable effects on survival. The heavier animals were more resistant than lighter ones. Females were more resistant than males during the "one-day" period but less resistant during the "ten-day" period. Following exposure to fast neutrons, the heavier rabbits again showed less mortality, but there were no significant sex differences. After either x or neutron irradiation, the majority of deaths occurred in the 4- to 20-day period. A distinct peak of deaths was evident 10 days after x irradiation, but after neutron exposures mortality during the 4- to 20-day period was divided into two phases with modes at about 8 and 12 days. For rabbits, the 30-day $LD_{50}$ was 825 r of x rays or 145 n units of neutrons; the x/n ratio was accordingly 5.7. For mean survival times the ratio was 6.3. Mice died in greatest numbers during the first 10 days after exposure to either neutrons or x rays, but the average survival after neutron exposure was about 4 days shorter than after x irradiation. The 30-day $LD_{50}$ was 540 r or 54 n, the x/n ratio accordingly being 10.

515

University of Rochester Atomic Energy Project
THE EFFECTS OF ACUTE EXPOSURE TO ROENTGEN RADIATION ON THE PERIPHERAL BLOOD OF EXPERIMENTAL ANIMALS. M. Ingram and W. B. Mason. July 17, 1950. 36p. (UR-122)

Rats, dogs, and monkeys have been exposed to single whole-body doses of roentgen radiation. The dosage for rats varied from 5 to 1500 r and that for monkeys from 300 to 2000 r. Dogs received 300 r, a dose approximating $LD_{50}$. Hemograms of all animals were determined at regular intervals for 25 to 60 days following irradiation. Bone marrow examinations were included in the studies utilizing doses approximating $LD_{50}$. The data pertaining to monkeys have been excluded from the present report because of extraneous infections which invalidate attempts to relate the observed changes to the radiation received. The major findings may be summarized as follows: (1) Results of the present experiments indicate that routine hematological examinations are inadequate for detecting slight radiation damage in any one individual. Changes which occur following exposure to small doses can be demonstrated only by statistical methods. (2) The results of routine hematological examinations appear to be unreliable as criteria for determining the prognosis following isolated instances of whole-body exposure to roentgen radiation. No consistent or convincing difference between leukocyte counts of survivors and nonsurvivors could be demonstrated in the various experiments. (3) Lymphocytes and reticulocytes are similar with regard to the promptness and magnitude of their depression following single exposures to whole-body radiation. In general, depression of these cells is more marked and occurs earlier than that of other elements of the peripheral blood. (4) The depression of neutrophils occurs slightly later than that of lymphocytes and reticulocytes. (5) Significant depression of eryth-

rocytes and hemoglobin is the last to occur following exposure, and the dosage required to produce such depression is much larger than that required to produce other changes. The recovery phase of the erythrocyte trends is characteristically preceded by a marked reticulocytosis. (6) With routine techniques, examination of bone marrow appears to offer no particular advantage in indicating radiation damage since changes are equally prompt in both marrow and peripheral blood cells. (7) In general, the magnitude of peripheral blood cell changes is roughly proportional to the dose for exposures up to approximately $LD_{50}$. Doses greater than $LD_{50}$ tend to induce the maximum response and, if sufficiently large, prove fatal in a relatively short time. (auth)

516

University of Rochester Atomic Energy Project
EXPERIMENTAL CONFIRMATION OF A PREVIOUSLY REPORTED UNUSUAL FINDING IN THE BLOOD OF CYCLOTRON WORKERS. M. Ingram and S. W. Barnes. Oct. 10, 1950. 8p. (UR-137)

The relationships between the increased incidence of lymphocytes with bilobed nuclei and exposure to radiation from the cyclotron has been confirmed experimentally. Three dogs were exposed on three different occasions to doses of radiation which were believed to be well below the tolerance dose. After each exposure there was a marked increase in the incidence of blood smears containing one or more of the abnormal lymphocytes. The frequency of occurrence of such smears was maximal during an approximately two-week period after each exposure. (auth)

517

ACTION OF X-RAYS ON THE EMBRYONIC DEVELOPMENT OF AMPHIBIA. V. A. Blinov. Doklady Akad. Nauk S.S.S.R. 74, 401-4(1950) Sept. 11. (In Russian)

Problems concerning relative sensitivity to x rays, both at different stages of embryonic life and at various points of the developing body, were investigated on axolotls and tritons (using 147 r/min dose intensity), and on frogs (1100 r/min), the lethality percentage serving as a sensitivity criterion. It was observed that the final phase of the blastula stage, the late neurula stage, and the time of the gill formation were by far the most sensitive (critical) periods in the embryo's life, as far as x rays were concerned. Furthermore, the maximum sensitivity is localized at the rear end during the early stages (being thus correlated with gastrulation disturbances), while in later periods it is concentrated at the fore (brain) end of the embryo.

518

DISTRIBUTION OF ABSORBED ENERGY AROUND A POINT SOURCE OF $\beta$ RADIATION. Robert Loevinger. Science 112, 530-1(1950) Nov. 3.

In order to compute the tissue-absorbed energy (or observed ionization) about an arbitrary distribution of $\beta$ emitters, it is necessary to know the spherically symmetrical function which gives these quantities as a function of distance from a point source of $\beta$ radiation in absorbing material. An explicit method of computing such a function, if measurements are made of a plane source with a plane ionization chamber, is derived. The experiment has been performed with radioactive phosphorus. With the results obtained, it is a straightforward matter to compute the dose due to any known distribution of $\beta$ emitter, though only the relatively simple sources such as plane slabs and spheres can be computed in analytic form.

519

THE EFFECT OF X-RADIATION ON ANTIBODY FORMATION. Leon O. Jacobson, Melba J. Robson, and Edna K. Marks. Proc. Soc. Exptl. Biol. Med. 75, 145-52 (1950) Oct. (See also NSA 4-993).

Experiments in which rabbits have been exposed to 800 r of x radiation have confirmed previous findings (Hektoen, J. Infectious Diseases 17, 415(1915)) that antibody formation is suppressed by total-body x radiation. It has been demonstrated, in addition, that if the spleen or appendix of the rabbit is protected by lead shielding during total-body irradiation, the capacity to produce antibodies to an injected particulate antigen is retained to a marked degree even though lymphatic tissue elsewhere in the body is temporarily destroyed.

520

REPORT OF "SYMPOSIUM ON MODE OF ACTION OF IONIZING RADIATIONS." Alma Howard. Nucleonics 7, No. 6, 26-30(1950) Dec.

In this account of the symposium proceedings, a statement of a few of the problems under attack serves as an analysis of the reaction and radiosensitivity of living cells to irradiation of various sorts. (auth)

## RADIATION HAZARDS AND PROTECTION

521

Brookhaven National Laboratory
EMERGENCY RESPIRATORY PROTECTION IN THE ATOMIC AGE. Julius Hannoch. July 1, 1950. 20p. (AECU-982)

A discussion is presented using as a basis the two objectives of a radiation safety program: (1) to assure that the external irradiation is kept below a permissible exposure limit, and (2) to prevent the entrance of radiomaterials into the body by ingestion, inhalation, or through the skin. Accomplishment of the first objective is facilitated by maintaining proper distance between the radiation source and the individual exposed, by limiting the time during which an individual is exposed to the radiation, or by interposing appropriate shielding between the exposed personnel and the sources of radiation. The second objective of a radiation safety program, to prevent the entrance of radiomaterials into the body by inhalation, ingestion, or through the skin, is accomplished with the customary difficulties attendant upon any control measure in which elements of personal habit are involved. A brief survey of respiratory protective equipment is included.

522

Naval Radiological Defense Laboratory
A CHART FOR ESTIMATING DOSAGE TIME FACTORS FOR PERSONNEL EXPOSED TO MEASURED RADIATION FIELDS. R. E. Young and C. J. Camp. Jan. 10, 1950. 7p. (AD-189(O);NRDL-12)

A three-scale nomograph for calculation of maximum permissible exposure time for personnel who handle radioisotopes or who are exposed to ionizing radiation is presented. Several examples of its use are given.

523

Kellex Corp.
JULY SUMMARY PROGRESS REPORT; GAS DECONTAMINATION (24-A-2). Aug. 4, 1950. 6p. (KLX-1308)

During this report period the experimental equipment was modified to permit multiple treatment with water fog and sonic agglomeration. Study of build-up techniques as applied to water-soluble (NaCl) aerosol suspensions were continued, and preparations were made for the study of water-insoluble (AgI) aerosols.

524

Los Alamos Scientific Laboratory
AIR DECONTAMINATION TESTS WITH BAFFLE PLATE TOWERS, CAPILLARY WASHERS, AND FIBERGLAS PADS. R. Philip Hammond and Joseph A. Leary. Sept. 1950. 80p. (LA-1145)

In this study tracer techniques were used throughout, with a few checks by other methods. The study centered around wet methods of collection because of the advantage of such methods in final disposal of collected radioactivity. Furthermore, continuous removal of the scrubber liquid permits control of the contamination level in the equipment. The glass-pad collectors which are described exhibited high efficiency which for small particles is surprising in view of their high operating velocity, low pressure drop, and loose construction. The results of collection efficiency measurements are reported in terms of "per cent passage," (100 minus per cent efficiency). For high efficiencies the "passage" reflects more significantly small changes in performance. Details of the baffle-plate tower pilot plant, the capillary-washer pilot plant, methods of sampling and counting, particle size measurements, and a sample calculation, are included with graphed data.

525

Mallinckrodt Chemical Works
HIGH EFFICIENCY COLLECTION OF RADIOACTIVE DUST. Knowlton J. Caplan. Apr. 10, 1950. 12p. (NYO-1525)

The nature of the problem of radioactive dust collection has been reviewed. The objects of prime importance are high efficiency, low (and easy) maintenance, and small amounts of waste which might require special disposal. Methods of test using the isokinetic principle have been described. Data have been presented showing errors involved when conventional room-air sampling equipment is used. The method of operation and some of the operating characteristics of the Hersey reverse-jet filter have been described and compared to other types of collectors in terms of applicability to radioactivity service. (auth)

526

University of Rochester
OUTLINE FOR COURSE IN RADIOLOGICAL PHYSICS. J. N. Stannard. Aug. 28, 1950. 31p. (UR-133)

The course outlined herein was organized primarily for first-year graduate instruction in the field of radiological physics, and is accredited, after completion of a suitable thesis and oral examinations, for the degree of Master of Science in radiation biology. Primary emphasis has been placed upon the medical and biological problems introduced by the preparation and use of fissionable materials for the release of atomic energy (i.e., "health physics"). Sufficient background in pure science is given to prepare the student for research in related fields as well as for hospital and industrial applications of radiological physics. Detailed outlines are given for those courses offered by the Department of Radiation Biology. The content of others is indicated in the catalog descriptions.

527

A LUCITE SYRINGE SHIELD FOR PROTECTION AGAINST IRRADIATION DURING INTRAVENOUS ADMINISTRATION OF BETA-EMITTING RADIOISOTOPES. A. Pearl, W. F. Bethard, and L. O. Jacobson. J. Lab. Clin. Med. 36, 792-4(1950) Nov.

The problem of overexposing the hands to $\beta$ radiation during therapeutic intravenous administration of $\beta$-emitting radioisotopes is discussed. Plans for a simple, effective, lucite syringe shield are shown.

528

SENSITIVITY OF THE EVAPORATION METHOD OF LIQUID-WASTE MONITORING. Frederick P. Cowan and John V. Nehemias. Nucleonics 7, No. 5, 39-44(1950) Nov.

A statistical criterion for the detectability of radioactivity in waste liquids is stated here and applied, by way of example, to evaluation of minimum detectable concentrations for the effluent from Brookhaven's sewage-processing plant.

529

Industrial Radiology Laboratory, National Research Council of Canada
SHIPPING, STORAGE, AND HANDLING OF COBALT 60. K. J. Parry. Dec. 1949. 17p. (NRC-2026)

The measurement of $Co^{60}$ source strength, ionization produced by 1 mg Ra equivalent of $Co^{60}$, and attenuation of $Co^{60}$ $\gamma$ rays by lead shields are summarized. Graphs facilitating the selection of the proper shipping container are presented, and the use of the containers as exposure mountings is illustrated. Distances to be maintained between sources being stored or handled and personnel or

photographic film for various exposure rates are given. Some handling tools for $Co^{60}$ are illustrated.

## RADIATION SICKNESS

530

Naval Medical Research Institute
SULFHYDRYL-CONTAINING AGENTS AND THE EFFECTS OF IONIZING RADIATIONS; II. FURTHER STUDIES OF THE BENEFICIAL EFFECT OF GLUTATHIONE ON X-IRRADIATED MICE. W. H. Chapman and E. P. Cronkite. June 20, 1950. 9p. (NP-1833)

The effects of the subcutaneous injection of glutathione, prior to irradiation, were studied in four consecutive experiments in which 2343 male, Swiss Albino mice were exposed to various doses of total-body x radiation. The lethal dose curves for glutathione-injected and nontreated mice were simultaneously determined in each experiment. The 28-day $LD_{50}$ for the nontreated mice was 740 r; for mice that received 1.6 mg of glutathione per gram of mouse, the 28-day $LD_{50}$ was 840 r, and for mice that received 4.0 mg of glutathione per gram of mouse, the 28-day $LD_{50}$ was 950 r. These results indicate a quantitative relationship between glutathione dosage and the degree of protection it affords against x-ray damage. Weight change and the effect of trauma were studied in the irradiated survivors in an attempt to demonstrate differences in the recovery rates of the glutathione-injected and the nontreated mice. For these studies, all mice were weighed daily throughout the 28-day observation period of each experiment and on the 29th day all surviving animals were subjected to controlled mechanical trauma produced by a Noble-Collip drum. The glutathione-injected mice lost less weight and were more resistant to trauma than their nontreated controls. (auth)

## RADIOGRAPHY

531

New England Deaconess Hospital and Harvard Cancer Commission
RADIOAUTOGRAPHIC SOLUBILITY STUDIES OF $I^{131}$ AND $P^{32}$ IN FROZEN-DEHYDRATED TISSUES. Margaret W. Holt and Shields Warren. [nd.] 21p. (AECU-1023)

Previous work with a method for preparation of animal tissues for radioautographical study which consisted of quick-freezing by immersing the tissues in isopentane at −170°C followed by vacuum dehydration of the frozen tissue and infiltration of the dried tissue with paraffin under vacuum had demonstrated that if a section of rat liver containing $P^{32}$ which had been thus prepared was floated on water for a few seconds before it was mounted, essentially all the $P^{32}$ was lost from the tissues. The present report describes results obtained when frozen-dehydrated tissue sections containing $P^{32}$ or $I^{131}$ were exposed to extraction by a variety of reagents, both aqueous and nonaqueous. Radioautographic exposures were made with the extracted tissue sections and also with nonextracted control sections. The results were evaluated by comparing the photographic densities and pattern of localization of radioautographs obtained from analagous tissue sections subjected to various types of extraction with those of the control sections.

532

University of Rochester Atomic Energy Project
MICROSCOPIC AUTORADIOGRAPHY AS A TOOL IN CANCER RESEARCH. George A. Boyd. July 24, 1950. 17p. (UR-124)

The photographic emulsion has an advantage over the conventional electronic instruments used in biological tracer studies in that it can be used to trace radioactivity to an individual cell or small collection of cells under the microscope. To date, the cellular studies have been qualitative, but quantitative studies are feasible. A general discussion of radioautography of tumors, blood cells, and various tissues is presented. 7 figures.

533

SINGLE CELL AUTOGRAPHS OF BONE MARROW AND BLOOD FROM RATS USING RADIOACTIVE PHOSPHORUS. William I. Morse. Am. J. Med. Sci. 220, 522-9(1950) Nov.

Single-cell autographs of marrow and peripheral blood elements are reported for the first time following the injection of $P^{32}$ in rats. In the small number of satisfactory preparations studied, the youngest erythropoietic and granulopoietic forms from the marrow have the most intense autographs, indicating rapid phosphorus turnover. Autographs of megakaryocytes and lymphocytes are faint at best. If the observation of more selective uptake by marrow elements than occurs in the lymphatic system is substantiated, it would suggest that radioactive phosphorus has some advantages over x-ray therapy in myelogenous leukemia. The technique at present has many limitations. Desirable improvements and some applications to hematological problems are discussed. (auth)

## RADIOTHERAPY

534

University of Rochester Atomic Energy Project
RADIOIODINE ($I^{131}$) PRINCIPLES OF DIAGNOSIS AND TREATMENT OF THYROID DISEASE. B. J. Duffy, Jr., and J. W. Howland. Oct. 25, 1950. 23p. (UR-138)

With the increasing clinical use of radioactive iodine ($I^{131}$) there is need for a simple formulation of physical principles, treatment techniques, and bibliography of pertinent articles bearing on specialized phases of $I^{131}$ therapy. This report is an attempt to supply the clinician with some basic facts about $I^{131}$ which will enable him to utilize more effectively this agent in the diagnosis and treatment of thyroid disorders. (auth)

535

GERMAN ISOTOPE RESEARCH IN MEDICINE. Fritz Ruf and Kurt Philipp. Umschau 50, 539-41(1950) Sept. 1. (In German)

German medical researchers have obtained radioactive isotopes from the atomic pile at Harwell, England, and from the cyclotron at Heidelberg. An account is presented of some of the research being undertaken at various German medical centers on blood circulation and clotting, metabolism, bone growth and healing, thyroid therapy, and tuberculosis diagnosis with radioactive isotopes, in particular with $P^{32}$, $Na^{24}$, $Ca^{45}$, and $I^{131}$. Autoradiographs of healing broken bones and of diseased thyroid glands are given.

## TOXICOLOGY STUDIES

536

Hanford Works Health Instruments Division
THE NITROGEN MUSTARDS; A REVIEW. C. W. DeLong. Jan. 30, 1950. 30p. (HW-18823)

The major aspects of nitrogen mustard research are reviewed. The chemistry, pharmacology and toxicology, cellular and nuclear actions, clinical and pathological effects, mechanism of action, and differences in biological action from x rays are discussed for these compounds. The use of the nitrogen mustards in cancer therapy is discussed under the topics of dosage, signs and symptoms of toxicity, indications for use, and diseases in which these compounds may be effective. 58 references.

## TRACER APPLICATIONS

537

Brookhaven National Laboratory
RADIATION MICROBIOLOGY; PROBLEMS AND PROCEDURES. B. A. Rubin. [nd.] 49p. (AECU-984)

The problems involved in the irradiation of microorganisms by "machines" or by isotopes are considered. Past disagreements are related to the problems of dose and quality measurement. The techniques of "labeling" microorganisms with radioactive isotopes are found to possess certain common characteristics and problems. Methods are presented for handling radioactive solutions to be used in culture media. Devices are described for preparing and centrifuging radioactive cultures; for ultraviolet sterilization of "active" solutions; for automatically plotting the growth curves of cultures in radioactive media; for simultaneously exposing several bacterial suspensions to an external irradiation source while maintaining careful control of dose rate per organism, temperature, etc. (auth)

538

Brookhaven National Laboratory
PHOSPHATE TRANSPORT AND TURNOVER IN THE LIVER. Jacob Sacks. [nd.] 27p. (AECU-987)

The time course of the relative specific activities of plasma inorganic P and of the acid-soluble P fractions of liver has been studied in male rats of the Carworth and Sprague-Dawley strains. In both strains, the disappearance of the tracer from plasma following subcutaneous injection takes place by two simultaneous processes. The rapid one, which is considered to represent primarily the establishment of diffusion equilibrium between plasma and the interstitial fluids of the tissues, has a half-time of about 0.5 hr in both strains. The slow one, which is considered to represent primarily the over-all transport rate into the tissue cells, has a half-time of about 3 hr in the Carworth-strain animals and of about 6 hr in the Sprague-Dawley strain. The relative turnover rates of the labile P of ATP-ADP and of glucose-1-phosphate of the liver were about twice as high in the Carworth as in the Sprague-Dawley strain. The experimental data are consistent with the hypothesis that phosphate enters the liver cell by formation of ATP-ADP and glucose-1-phosphate on the membrane, in that the plasma inorganic P meets the necessary conditions for being the immediate precursor of the P of these fractions. Neither plasma P, ATP-ADP, nor glucose-1-phosphate meets the necessary conditions for being the source of the P for the formation of glucose-6-phosphate. The indicated turnover rates for the phosphorylated intermediates are very much higher than those previously found for muscle. This is interpreted as showing that the phosphorylation cycle plays a quantitatively more important part in the metabolism of liver than it does in muscle.

539

Los Alamos Scientific Laboratory
TIME STUDIES OF THE PENETRATION OF EXTRACTED HUMAN TEETH BY RADIOACTIVE NICOTINAMIDE, UREA, THIOUREA, AND ACETAMIDE; II. PENETRATION OF DENTIN FROM THE PULP CHAMBER. W. W. Wainwright and H. H. Belgorod. [nd.] 27p. (AECU-999; LADC-863)

Isotope-labeled solutions of nicotinamide, urea, thiourea, and acetamide were tested for their ability to penetrate dentin by placing them in the cleaned pulp chambers of extracted human teeth. Twenty-one unfixed and 5 formol-fixed teeth were treated, stored in a humid atmosphere, and after periods of 6 min to 3 days were sectioned under oil and examined radioautographically. $C^{14}$-nicotinamide, $C^{14}$-urea, $S^{35}$-thiourea, and $C^{14}$-acetamide penetrated dentin rapidly. Each compound penetrated through approximately 3.5 mm of dentin to reach the dento-enamel junction in about 20 min. Acetamide penetrated through the dentin (4.1 mm) and faintly through the enamel (2.1 mm) within 22 min at 37°C. (auth)

540

Harvard Medical School and Peter Bent Brigham Hospital
DETERMINATION OF THE CIRCULATING RED CELL VOLUME IN MAN BY RADIOACTIVE CHROMIUM. K. Sterling and S. J. Gray. [nd.] 15p. (AECU-1026)

A new biological tracer, radioactive chromium, $Cr^{51}$, with a half-life of 26.5 days, has been employed for the determination of the circulating red cell volume in man. A small aliquot of the subject's erythrocytes was tagged rapidly in vitro with radioactive sodium chromate and was reinjected within a few hours. After the tagged cells had mixed in the circulation, the radioactivity of the subject's erythrocytes was determined. The circulating red cell volume was calculated by the isotope dilution principle.

The radioactivity of the circulating red blood cells remained constant for approximately 24 hr without significant loss to the plasma. Repeated measurements of the red cell volume were reproducible within 5% for approximately 24 hr. The accuracy of the method was within 5% and was verified by hemorrhage and transfusion experiments with measured volumes of blood. The circulating red cell volumes of 25 normal male medical students were determined: mean circulating red cell volume, 2351 cc; mean red cell volume per kilogram body weight, 31.8 cc; mean red cell volume per square meter surface area, 1.21 liters. (auth)

541

Harvard Medical School and Peter Bent Brigham Hospital
THE TAGGING OF RED CELLS AND PLASMA PROTEINS WITH RADIOACTIVE CHROMIUM. Seymour J. Gray and Kenneth Sterling. [nd.] 30p. (AECU-1027)

A new biological tracer, radioactive chromium, $Cr^{51}$, with a half-life of 26.5 days was found to tag both red blood cells and plasma proteins. The anionic hexavalent form of the isotope ($Na_2Cr^{51}O_4$) labeled red blood cells while the cationic trivalent form ($Cr^{51}Cl_3$) was firmly bound by plasma proteins. The addition, in vitro, of 86 $\gamma$ or chromium as the chromate to a 5-cc suspension of red cells in saline resulted in an uptake of 80 to 90% of the radioactivity within 2 hr. The intravenous injection of $Na_2Cr^{51}O_4$ in dogs resulted in a rapid tagging of the red cells which retained their radioactivity for a prolonged period, while the plasma activity fell rapidly. Washed red cells, tagged with $Na_2Cr^{51}O_4$ in vitro, were injected intravenously into dogs and retained their activity without significant loss to the plasma for approximately 24 hr. The site of tagging of the erythrocyte with $Na_2Cr^{51}O_4$ appeared to be the globin portion of hemoglobin. Hemoglobin demonstrated a significantly greater binding capacity for $Cr^{51}Cl_3$ than for $Na_2Cr^{51}O_4$. Cationic trivalent chromium, in contrast to anionic hexavalent chromium, was not taken up by the red blood cells, presumably because of the impermeability of the cell membrane to the cation. It is suggested that anionic hexavalent chromium diffuses through the red cell membrane and is bound by hemoglobin within the cell probably after reduction to the cationic trivalent state, resulting in the firm tagging to the erythrocyte. An albumin solution labeled with $Cr^{51}Cl_3$ contained 29.9 $\mu$c/g after dialysis and did not differ from native albumin by ultracentrifuge and electrophoretic analysis. (auth)

542

Oak Ridge National Laboratory
THE INTERPRETATION OF EXPERIMENTAL INVESTIGATIONS OF TRANSFERS WITHIN A TWO-COMPARTMENT SYSTEM, USING ISOTOPIC TRACERS. C. W. Sheppard and A. S. Householder. Dec. 29, 1949. 53p. (ORNL-497)

The theory of the movement of a radioactive tracer from one compartment to another of a two-compartment equilibrium system containing a tagged substance S is reviewed. If $a_1$ and $a_2$ are the specific activities and $S_1$ and $S_2$ are the total amounts of material in compartments 1 and 2, respectively, and if, at $t = 0$, $a_1 = a_0$, and $a_2 = 0$, the values of a at any later time t are related to the exchange rate $\rho$ by the equations

$$a_1/a_0 = \frac{S_1 + S_2 e^{-\rho\left(\frac{1}{S_1}+\frac{1}{S_2}\right)}}{S_1 + S_2}$$

$$a_2/a_0 = \frac{S_1\left[1 - e^{-\rho\left(\frac{1}{S_1}+\frac{1}{S_2}\right)}\right]}{S_1 + S_2}$$

Methods are described for determining $\rho$ from measurements of the S's and the a(t)'s. It is shown that the results are not affected by volume changes provided the S's remain constant. An approximate expression is derived from the equations with which experimental results in cellular systems may be corrected for isotope exchange during the centrifugal separation of the cells. Equations are derived for the case where two kinds of S are being exchanged. An n-compartment system is discussed in which a central compartment can exchange with $n - 1$ peripheral compartments, and equations are derived which describe the specific activity changes. These are particularized to the case where $n = 3$. It is shown that if the two exchange rates differ widely then the results may be expressed in terms of two separate exponentials characteristic of the two separate exchange rates. In the more general case each exchange process affects the other. The analysis of the n-compartment system is applied to the study of the exchange of S between cells and plasma of mammalian blood in vitro where the exchange rates between the two fractions are statistically distributed. In a typical case, even though the spread is extreme, the departure of the results from the pure exponential behavior of a 2-compartment system is less than 3% during the initial phase where t is less than 1 half-time value. An analogy with Fick's law of diffusion is applied to the determination of the radioactivity changes in a tagged system where the concentration of S is held constant in time but not in space. (auth)

543

Oak Ridge National Laboratory
THE USE OF ISOTOPES IN SOIL RESEARCH. G. R. Noggle. Nov. 6, 1950. 21p. (ORNL-863)

After a general discussion of the use of stable and radioactive isotopes as tracers in soil fertility studies, the author briefly reviews some of the research carried out or suggested by the use of $P^{32}$, $N^{15}$, $K^{41}$, $Ca^{45}$, $S^{35}$, and other tracers. Applications of tracers to the investigation of weed killers and insecticides are suggested, and the influence of radioactive materials on plant growth is briefly discussed.

544

Oak Ridge National Laboratory
INCORPORATION OF ISOTOPIC FORMATE INTO THE NUCLEOTIDES OF RIBO- AND DESOXYRIBONUCLEIC ACIDS. J. R. Totter, Elliot Volkin, and C. E. Carter. Oct. 30, 1950. 11p. (ORNL-866)

Experiments utilizing $C^{14}$-labeled formate were carried out for the purpose of gaining some insight into the apparent relationship of folic-acid function and nucleic-acid metabolism. The in vivo incorporation of formate into mononucleotides isolated from purified visceral ribo- and

desoxyribonucleic acids of the rat and chick on complete diets, and the folic-acid-deficient chick, was investigated. The results indicate that formate is assimilated directly into the methyl group of thymidylic acid, as well as into the purines of both ribo- and desoxyribonucleic acids. No evidence was found for an inability of the folic-acid-deficient chick to utilize formate for nucleic acid synthesis, lending support to the hypothesis that folic acid may be more directly concerned with the formation of formate from glycine and serine. Differences in activity among the nucleotides of ribo- and desoxyribonucleic acids from the control and deficient chicks, as well as those from the rat and chick are discussed. (auth)

# CHEMISTRY

545

Brookhaven National Laboratory and Sterling Chemistry Laboratory, New Haven, Conn.
THE JONES REDUCTOR; A MODEL FOR THE KINETICS OF CHROMATOGRAPHY. Kerro Knox and Henry C. Thomas. [nd.] 13p. (AECU-986)

The Jones reductor can be made to assume a steady state of operation in the reduction of ferric sulfate. Its behavior under such conditions strongly indicates that the rate-limiting process is the diffusion of ferric ion through a static film of solution around the solid particles. This is particularly evidenced by the exponential dependence of the extent of reduction on the square root of the flow rate. The behavior of the reductor as a function of zinc ion concentration, zinc amalgam particle size, and temperature also agrees with this result. (auth)

546

Oak Ridge National Laboratory
I. THE CRYSTAL STRUCTURE OF POTASSIUM PERRUTHENATE; II. STUDIES OF THE UPPER VALENCE STATES OF RUTHENIUM IN AQUEOUS SOLUTIONS. M. D. Silverman and H. A. Levy. Nov. 13, 1950. 129p. (ORNL-746)

The crystal structure of potassium perruthenate has been determined to be of the scheelite type, space group $C_{4h}^6$-$I4_1/a$; the unit cell, containing four molecules of $KRuO_4$, has the dimensions $a_0 = 5.609 \pm 0.002$ A and $c_0 = 12.991 \pm 0.002$ A. The parameters of the oxygen atoms have been determined by using equatorial Weissenberg photographs. The atomic positions are Ru at (0 0 0), K at (0 0 $\frac{1}{2}$), 0 at (x y z) and crystallographically equivalent positions with $x = 0.75_6$, $y = 0.11_7$, $z = 0.92_7$, accurate to about 0.002. The ruthenium coordination is a tetrahedron slightly flattened along the c axis, with a Ru-to-O distance of 1.79 A. The disproportionation of ruthenate to perruthenate and ruthenium dioxide does not reach stable equilibrium. Aqueous perruthenate ion is unstable, decomposing by disproportionation at pH below 10.65 or by discharging oxygen at pH above 10.65. Potentials of 0.59 and 1.00 volts have been obtained for the ruthenate-perruthenate and perruthenate-ruthenium tetroxide couples, respectively, by polarographic methods using a solid platinum electrode. These potentials have been used to calculate equilibrium constants for several reactions. The acid ionization constant of ruthenium tetroxide has been determined to be $1.3 \times 10^{-13}$ by a method involving the extraction of the tetroxide from aqueous and alkaline solutions with carbon tetrachloride. The value obtained is discussed with particular reference to theories for the ionization constants of inorganic oxygen acids. (auth)

547

A STUDY OF THE REACTION BETWEEN NITROGEN AND TITANIUM CARBIDE. A. N. Zelikman and N. N. Gorovits. Zhur. Priklad. Khim. 23, 689-95(1950) July. (In Russian)

Nitration of TiC in the temperature interval 1300 to 1800°C results in the formation of solid solutions TiC-TiN, the equilibrium depending on the latter's composition and on the pressure of $N_2$. Measurements were made of the pressure and temperature dependences of the equilibrium constant.

## ANALYTICAL PROCEDURES

548

Battelle Memorial Institute
TOPICAL REPORT ON THE DIRECT MICRO DETERMINATION OF URANIUM USING A MODIFIED FLUOROPHOTOMETER. E. J. Center. June 30, 1948. 43p. (AECD-3006; BMI-JDS-129)

A direct method for the determination of small amounts of uranium by fluorescence in a variety of materials is described. Equipment necessary and operating conditions are described in detail. The analytical procedure is simple and rapid; an accuracy of ±5% is obtained. 12 figures.

549

Harvard Medical School
A METHANE, PROPORTIONAL COUNTING METHOD FOR THE ASSAY OF TRITIUM. C. V. Robinson. [nd.] 11p. (AECU-1033)

A new method for the assay of tritium is described. Radioactive water is reacted with methyl Grignard reagent to give radioactive methane which is then admitted into a proportional counting chamber to be counted. Advantages of the method are convenience, absence of memory effects, linearity, and a precision with a standard deviation less than 1%. (auth)

550

M.I.T. Mineral Engineering Laboratory
QUANTITATIVE DETERMINATION OF BERYLLIUM BY USE OF THE PHOTODISINTEGRATION REACTION. James H. Pannell. Sept. 15, 1950. 23p. (MITG-227)

The $\gamma$,n reaction, which has been successfully applied to automatic sorting of beryl, is susceptible of application to the analysis of beryllium. A method for so utilizing the reaction has been developed and applied to low-grade beryl ores and ore-testing products. (auth)

551

M.I.T. Mineral Engineering Laboratory
FURTHER STUDY OF SIMULTANEOUS RADIOMETRIC ASSAY FOR THORIUM AND URANIUM; INCLUDING THE USE OF THE COOKE-YARBOROUGH QUENCHING CIRCUIT. Donald W. Haney and Emilia M. Rubino. Oct. 18, 1950. 22p. (MITG-237)

A further study of the simultaneous radiometric assay technique for thorium and uranium shows an average percentage accuracy of 21%. The error is larger for the minor constituent. The advantage of the technique lies in the short time in which the assays may be executed. Moderate accuracy may always be expected even though the ores being assayed are out of radioactive equilibrium.

552

New Brunswick Laboratory
THE DETERMINATION OF RADIUM OR RADON IN GASES, LIQUIDS OR SOLIDS. J. E. Hudgens, R. O. Benzing, J. P. Cali, R. C. Moyer, and L. C. Nelson. May 10, 1950. 23p. (NYO-2010)

An accurate method for the determination of the concentration of radon or radium in gaseous, liquid, or solid samples by transferring the released radon to counting chambers has been described. Details of the chemical techniques and of the electronic equipment required are given. The limit of detection is approximately $10^{-20}$ g of radon, or $10^{-14}$ g of radium.

553

ERRORS OF COMBUSTION OF COMPOUNDS FOR $C^{14}$ ANALYSIS. W. D. Armstrong, Leon Singer, S. H. Zbarsky, and Bryant Dunshee. Science 112, 531-3(1950) Nov. 3.

Large discrepancies have been noted between $C^{14}$ assays of the $CO_2$ obtained by oxidation of xanthydrol ureide labeled in the urea residue, indicating large differences between the rates of conversion of $C^{12}$ and $C^{14}$ atoms. These differences were noted when both wet and dry oxidation methods were used. Because of these findings the work was extended to demonstrate discrimination between carbon isotopes when $C^{14}$-labeled urea was converted to $CO_2$ by wet oxidation. The results make it clear that it is necessary to oxidize completely xanthydrol ureide or urea, and to collect completely the evolved $CO_2$, if reproducible results are to be obtained on $C^{14}$ assay of barium carbonate derived from these compounds by wet oxidation.

554

A NEW REAGENT FOR URANIUM. A. K. Dasgupta and J. Gupta. J. Sci. Ind. Research (India) 9B, 237(1950) Sept.

Short preliminary note is made of the use of oxalo-hydroxamic acid for the detection and colorimetric determination of U. An orange-colored complex is formed in slightly acid or ammoniacal solutions. The limit of identification determined on a spot plate is 0.2 $\gamma$.

555

QUANTITATIVE DETERMINATION OF BORON AND FLUORINE IN THE PRESENCE OF EACH OTHER. D. I. Ryabchikov and V. V. Danilova. Zhur. Anal. Khim. 5, 28-31(1950) Jan.-Feb. (In Russian)

A colorimetric determination of boron is recommended, in which use is made of a color reaction described by Kazarinova-Oknina (Zavodskaya Lab. 3(1948)): in the presence of B, a $H_2SO_4$ solution of carmine changes its color from red to dark blue. For this reaction, B is isolated through distillation with NaF and $H_2SO_4$, and, since F interferes with the color reaction, a separation is necessary. This is done with the aid of a cation-exchange resin (e.g., $BF_3 + 3HCat \rightarrow 3HF + BCat_3$ followed by elution with HCl). A method of determination of B and F in the presence of each other is based on these procedures supplemented by a separation of F with the aid of an anion-exchange resin and the following determination of F with zirconium-alizarin (Danilova, Trudy Biogeokhim. Lab. Akad. Nauk S.S.S.R. 7(1944)).

556

USE OF o-PHENANTHROLINE FOR A QUANTITATIVE DETERMINATION OF VANADIUM. A. Gottlieb. Oesterr. Chem. Ztg. 51, 102(1950) June (Note; in German).

Whereas in alkaline media the reaction $V(IV) + Fe(III) \rightleftarrows V(V) + Fe(II)$ proceeds to the right, it goes quantitatively to the left in acid solutions. In the first case, the Fe(II) formed can be combined with o-phenanthroline into a stable complex suitable for colorimetric analyses. In this way vanadium can be quantitatively determined, if the mixture is previously reduced by heating with HCl (whereby $V(V) \rightarrow V(IV)$). This method is more accurate than an analogous one where dimethylglyoxime is used, and it is much more sensitive than the determination of V with $H_2O_2$.

## CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

557

Knolls Atomic Power Laboratory
ON THE SYMMETRY OF GRAPHITE. Joseph S. Lukesh. June 5, 1950. 17p. (Memo-JSL-8)

X-ray diffraction evidence has been presented which indicates that the symmetry of graphite is no higher than twofold rather than hexagonal. The cell is probably orthorhombic with the space group $D_{2h}^{23}$-Fmmm. The lattice constants are $a_0 = 4.254$ kx, $b_0 = 36.840$ kx, $c_0 = 6.696$ kx. The evidence consists in (a) high frequency of occurrence of twins with a common c axis rotated 2.5 deg from one another (twins have been found in specimens from all sources studied including six naturally occurring samples and one synthetic) and (b) a set of satellite reflections having only twofold symmetry. These also have been found in all samples studied. This evidence, which is incompatible with a structure built of equiangular and equilateral hexagonal rings of carbon atoms, leads to the postulate of unequal

carbon bonds, a concept which may well influence theoretical studies of the band structure and the Brillouin zone pattern. (auth)

558

PREPARATION OF SINGLE CRYSTALS OF MANGANOUS FLUORIDE. THE CRYSTAL STRUCTURE FROM X-RAY DIFFRACTION. THE MELTING POINT AND DENSITY. Maurice Griffel and J. W. Stout. J. Am. Chem. Soc. 72, 4351-3(1950) Oct.

The preparation of single crystals of $MnF_2$ from the melt in an atmosphere of HF is described. From x-ray diffraction measurements the parameters of the tetragonal unit cell, each containing two molecules of $MnF_2$, are a = (4.8734 ± 0.0005 0.0005) × $10^{-8}$ cm and c = (3.3103 ± 0.0010 × $10^{-8}$ cm at 25°C. The parameter u that determines the position of the fluorine atoms in the space group $D_{4h}^{14}$ is 0.310 ± 0.005. The density calculated from the x-ray parameters is 3.925 ± 0.003 g/cm³. The measured density is 3.922 ± 0.004 at 25°C. The melting point of $MnF_2$ is 929.5 ± 0.5°C. (auth)

559

RECENT APPLICATIONS OF NEUTRON DIFFRACTION. A. H. Weber. Nucleonics 7, No. 6, 31-39(1950) Dec.

Particular advantages of neutrons over x rays as research tools are emphasized so that readers can evaluate the ideas and methods presented for application to their own problems. (auth)

## FLUORINE AND FLUORINE COMPOUNDS

560

Carbide and Carbon Chemicals Division, UCCC, K-25 THE PREPARATION OF NITROSYL FLUORIDE AND NITRYL FLUORIDE. A. V. Faloon and W. B. Kenna. Oct. 9, 1950. 9p. (K-672)

Nitrosyl fluoride (NOF) and nitryl fluoride ($NO_2F$) were prepared by direct vapor-liquid fluorination of nitric oxide and nitrogen dioxide, respectively. The fluorinations were carried out in a Fluorothene reactor at temperatures just above the melting points of the oxides to give products requiring little or no purification. Nitrosyl fluoride, having an observed gaseous molecular weight of 48.6, was found to have the boiling range 213 to 214°K. Nitryl fluoride, with an observed molecular weight of 64.7, had the boiling range 200 to 201 K. Both compounds are colorless in the gas or liquid states and are white in the solid state.

561

FLUORINATED ETHERS. Albert L. Henne and Malcolm A. Smook. J. Am. Chem. Soc. 72, 4378-80(1950) Oct.

Ethers with polyfluorinated groups on one or on both sides of their oxygen atom have been synthesized. The stability of the halogens, the strength of the oxygen bridge, and the loss of basic character of the ether function have been examined and related to the position of the fluorinated groups. (auth)

562

FLUORINATION OF METHOXYDICHLOROPHOSPHINE. Donald Ray Martin and Philip J. Pizzolato. J. Am. Chem. Soc. 72, 4584-6(1950) Oct.

Methoxydichlorophosphine has been synthesized by the reaction of methanol with phosphorus(III) chloride (yield about 60%), and has been fluorinated by means of the Swarts reaction to give methoxychlorofluorophosphine and methoxydifluorophosphine. These compounds have been purified and characterized by determination of their molecular weights, percentage compositions, freezing points, vapor pressures, heats of vaporization, boiling points, Trouton's constants, and liquid densities. The physical and chemical properties have been compared with those of phosphorus(III) chloride, methanol, the chlorofluorophosphines, and other similar compounds. (auth)

563

THE HYDROLYSIS OF 2-FLUOROQUINOLINE IN ACID SOLUTION. William K. Miller, Samuel B. Knight, and Arthur Roe. J. Am. Chem. Soc. 72, 4765-7(1950) Oct.

Spectrophotometric evidence has indicated that 2-fluoroquinoline is hydrolyzed to 2-hydroxyquinoline in acid solution, the rate of hydrolysis increasing with increasing acid concentration. The spectrum undergoes further change in very strongly acid solution, probably caused by the formation of the salt of 2-hydroxyquinoline. Spectral measurements have indicated that 2-chloroquinoline is not hydrolyzed in acid solution at normal temperatures but will form a hydrochloride if made strongly acid. (auth)

564

THE PREPARATION AND SOME REACTIONS OF 1,1,1-TRIFLUORO-2-ALKENES. Kenneth N. Campbell, James O. Knobloch, and Barbara K. Campbell. J. Am. Chem. Soc. 72, 4380-4(1950) Oct.

The reaction of aliphatic Grignard reagents with esters of trifluoroacetic acid has been investigated. With the larger Grignard reagents (n-propyl and n-hexyl) only the secondary alcohol was obtained; with ethylmagnesium bromide both the secondary and the tertiary alcohols were formed. 1,1,1-Trifluoro-2-octanone was reduced to the secondary alcohol by propylmagnesium bromide, and no addition occurred. When trifluoroacethyl chloride was treated with dihexylcadmium in benzene solution a low yield (22%) of the expected ketone was obtained. When the reaction was carried out in ether, the only product isolated was the tertiary alcohol, trifluoromethyldihexylcarbinol. 1,1,1-Trifluoro-2-octene and 1,1,1-trifluoro-2-pentene were prepared by pyrolysis of the corresponding secondary acetates. Some addition reactions of 1,1,1-trifluoro-2-octene have been investigated. (auth)

565

THE SPECTROPHOTOMETRIC DETERMINATION OF APPROXIMATE DISSOCIATION CONSTANTS OF THE

MONOFLUOROQUINOLINES. William K. Miller, Samuel B. Knight, and Arthur Roe. J. Am. Chem. Soc. 72, 4763-5(1950) Oct.

The dissociation constants of quinoline, the fluoroquinolines, and 6-chloroquinoline in 10% ethanol have been measured spectrophotometrically by the method of Stenstrom and Goldsmith (J. Phys. Chem. 30, 1683(1926)) and compared with values obtained by measurement of the pH of the salts of the bases. The dissociation constant of a fluoroquinoline was found to be weaker when the halogen is closer to the nitrogen atom. 6-Chloroquinoline is a weaker base than the 6-fluoro derivative. (auth)

566

SYNTHESIS OF AROMATIC FLUORIDES THROUGH DIAZOTIZATION IN ANHYDROUS HYDROGEN FLUORIDE. Richard L. Ferm and Calvin A. VanderWerf. J. Am. Chem. Soc. 72, 4809-10(1950) Oct. (Note)

Although fluorobenzene has long been obtained from aniline by the preparation and decomposition of benzenediazonium fluoride in anhydrous hydrogen fluoride, the general applicability of this method for the synthesis of aromatic fluorides has not been previously investigated. The following compounds were prepared successfully by this method with the percentage yields indicated: fluorobenzene (87%), o-fluorotoluene (73%), m-fluorotoluene (82%), p-fluorotoluene (78%), 4-fluoro-1,3-dimethylbenzene (57%), 2-fluoro-1,4-dimethylbenzene (43%), m-fluorochlorobenzene (81%), p-fluorochlorobenzene (74%), m-nitrofluorobenzene (39%), p-nitrofluorobenzene (62%), m-fluorophenol (46%), o-fluorobenzoic acid (57%), m-fluorobenzoic acid (78%), p-fluorobenzoic acid (98%), and o-fluorodiphenyl (82%).

## GRAPHITE

567

Argonne National Laboratory
THE HEAT OF REACTION OF GRAPHITE AND POTASSIUM. L. Quarterman and W. Primak. Oct. 10, 1950. 22p. (AECU-1018; UAC-318)

The heat of reaction of graphite with an excess of potassium has been carefully redetermined, and it has been shown that the result given in the literature, 125 ± 5 cal/g of graphite, is considerably in error. The present determinations were made over the temperature range 66 to 95°C. For high-density Acheson graphite, a mean value of 81 ± 2 cal/g was obtained. There seemed to be a variation of about 5% in the heat of reaction of samples obtained from the same bar. The heat capacity of the calorimeter was found to have increased 0.25 ± 0.01 cal for each gram of graphite introduced. Heats of reaction of some disordered forms of graphite were also determined, and results some 15% lower were indicated. (auth)

## LABORATORIES AND EQUIPMENT

568

Argonne National Laboratory Remote Control Division
NEW HOT LABORATORIES AT ARGONNE. H. L. Hull, R. C. Goertz, and K. R. Ferguson. Oct. 1949. Decl. Oct. 23, 1950. 13p. (AECD-2990; ANL-4385)

New hot laboratories have been constructed to provide improved facilities for physics and metallurgy research for reactor design and for special radiochemistry processing. Seeing and manipulation are very much improved. Samples up to 100 curies, 1 Mev gamma can be handled with safety, and a wide variety of physical-property measurements can be made by remote control. The master-slave manipulator is briefly described and illustrated, and the new transparent shielding windows are discussed. 3 figures.

569

Carbide and Carbon Chemicals Division, K-25
A LOW TEMPERATURE METAL DISTILLATION COLUMN FOR GASEOUS CORROSIVE COMPOUNDS. N. C. Orrick and J. D. Gibson. Nov. 2, 1950. 17p. (K-684)

A low-temperature analytical laboratory distilling column making use of metal construction and pressure transmitters was designed and fabricated. This apparatus was operated successfully in determining quantities of constituents present in mixtures when the individual components had boiling points 10°C or more apart from −100 to +3°C. Purification of individual compounds was also possible with substances whose boiling points were separated by 30°C or more. 7 figures. (auth)

570

Geological Survey
AN IMPROVED FLUORIMETER FOR THE DETERMINATION OF URANIUM IN FLUORIDE MELTS. Mary H. Fletcher and Irving May. June 1950. 16p. (USGS-TEI-120)

The Model R fluorimeter has been modified to increase its stability and sensitivity. The new instrument is about ten times as sensitive as the original fluorimeter, but it can also be employed conveniently at a sensitivity level comparable to or less than that of the Model R fluorimeter. (auth)

## RADIATION EFFECTS

571

University of Wisconsin
SOME EFFECTS OF TEMPERATURE, PHASE AND NATURE OF CHEMICAL SPECIES ON HALOGEN ATOM REACTIONS INITIATED BY RADIATIVE NEUTRON CAPTURE AND BY ISOMERIC TRANSITION. S. Goldhaber, R. S. H. Chiang, and J. E. Willard. [nd.] 18p. (AECU-1004)

The organic yield of bromine activated by either radiative neutron capture or isomeric transition in liquid $CCl_3Br$ appears to increase slightly when the temperature is lowered from room temperature to the melting point (1 to 5°C), increases abruptly with change from the liquid to the solid phase at the melting point, and increases slowly with cooling of the solid phase to −80°C. The increase in the organic yield is qualitatively parallel to the increase in density of the medium. The distribution of the organic products of the $(n,\gamma)$ reaction is about 45% $CCl_3Br$, 35% $CCl_2Br_2$, 20% higher boiling compounds at both 25 and −80°C. Increases in the

organic yield with decrease in temperature and/or change of phase occur for the (n,γ) reaction on bromine in $CCl_2Br_2$, in $CBr_4$, and in solutions of $Br_2$ in $CCl_4$, and for the (n,γ) reaction on chlorine in $CCl_4$ and in $CCl_2Br_2$. Low concentrations of bromine present in $CCl_3Br$ during neutron irradiation decrease the organic yield of $Br^{80}$ while low concentrations of α,β dibromoethylene increase the yield. The organic yield of iodine activated by the (n,γ) reaction in dilute solutions of iodine in saturated hydrocarbons averages about 35%, while that of dilute solutions of ethyl iodide in the same solvents averages about 60%. 18 references. (auth)

572

A STUDY OF THE DISCOLORATION OF METHYLENE BLUE PRODUCED BY X RAYS. Ya. L. Shekhtman, A. A. Krasnovskiĭ, and I. V. Vereshchinskiĭ. Doklady Akad. Nauk. S.S.S.R. 74, 767-9(1950) Oct. 1. (In Russian)

Methylene blue, dissolved in various concentrations in 0.1N $H_2SO_4$, was irradiated for 10 to 40 min by 250 r/min x rays; the ensuing discoloration was measured with the aid of a photoelectric spectrophotometer. The yield of the discoloration reaction is an almost linear function of the dose. The reaction is blocked by the presence of certain organic substances (chinone, hydrochinone, glucose, glycerin). The results agree with the known theory which sees in the decomposition of water the primary radiochemical action of radiations on water solutions; the products of that decomposition react with the dissolved body, or with the blocking substance. It was seen from the absorption spectra that, of the two forms of methylene blue present in the solution, the discoloration of the monomer proceeded faster than that of the dimer (a fact observed in the case of other dyes).

## RARE EARTHS AND RARE-EARTH COMPOUNDS

573

University of Illinois
OBSERVATIONS ON THE RARE EARTHS; 8-QUINOLINOL AND SUBSTITUTED 8-QUINOLINOL CHELATES OF CERTAIN RARE EARTH ELEMENTS. Dale Edward Jackson. Sept. 1, 1950. 101p. (NP-1800)

Investigations have been carried out on the preparation and properties of the chelates of certain rare-earth elements with oxine (8-quinolinol) and its 5,7-dichloro derivative. The observations on the precipitation of these complexes from aqueous media may be summarized as follows: (1) Several unsuccessful attempts to precipitate oxine and dichloroxine chelates from hot aqueous solutions are described. The materials prepared in this manner contained too little of the organic reagent for the theoretical 1-to-3, rare-earth-to-oxine, composition. (2) Several samples of lanthanum oxinate, $La(C_9H_6ON)_3$, were prepared by the addition of aqueous ammonia to a room-temperature mixture of lanthanum chloride and an excess of oxine. These substances were a dark, olive green. A similar procedure failed to yield an yttrium analog with the theoretical composition.

Although the dried, precipitated chelate materials were practically insoluble in several of the common organic liquids, two procedures are described for the preparation of chloroform solutions of the dichloroxine chelates. The studies on the absorption spectra of these solutions are abstracted in the following sentences: The absorption spectra of chloroform solutions of the dichloroxine chelates of neodymium and erbium are presented. In common these spectra showed a broad, intense peak near 4000 A which obscured all other bands due to the rare earths themselves at wavelengths below 5000 A. At longer wavelengths the characteristic peaks of the aqueous erbium and neodymium ions are preserved. However, they are greatly intensified and resolved into several peaks at wavelengths slightly different from those characteristic of the aqueous ions. Descriptions of several experiments are presented in which the 5818 A peak of neodymium dichloroxinate and the 5208 A band of the erbium compound (in chloroform solutions) were proved to obey Beer's law. Although the 4000 A peak (of both systems) probably obeys Beer's law, detailed studies on that band were not undertaken because of a lack of selectivity; i.e., the chelates of numerous cations absorb strongly near 4000 A. Several neodymium-containing rare-earth-oxide mixtures were converted to aqueous salt solutions, and the respective neodymium contents were determined spectrophotometrically. An account is presented of the corresponding spectrophotometric analyses of chloroform solutions of the respective dichloroxine chelates of these mixtures.

## SEPARATION PROCEDURES

574

Iowa State College
THE DESIGN AND DEVELOPMENT OF A SYSTEM FOR THE RECOVERY AND PURIFICATION OF HYDROGEN FLUORIDE FROM HYDROFLUORINATION WASTE GASES. Robert Henry Giffen. 1947. 58p. (AECD-2983)

Hydrogen fluoride was recovered from aqueous hydrofluoric acid by fractional distillation, followed by chemical combination and successive decomposition to separate the azeotropic mixture left after distillation. The value of the H.T.U. was found to vary from 0.746 to 1.62 ft for the packing employed, depending upon the method used to determine the number of theoretical stages. An over-all diffusion coefficient was calculated with the Chilton-Colburn equation for H.T.U. and found to be 0.0162 pound mole per hour per square foot of diffusion surface. The distillation rates in these experiments averaged 0.0247 pound mole per hour. Potassium hydrogen fluoride was prepared by adding potassium fluoride to 40% hydrofluoric acid. The crystals were identified as $KHF_2$, and Ditte's solubility relations of the system were confirmed. The crystals were stable at 110°C and were oven-dried. Potassium hydrogen fluoride was decomposed by heating with a gas burner to evolve hydrogen fluoride and finally leave a residue of potassium fluoride. Suggestions for the guidance of future investigation have been given, with special reference to different methods of recovery than the one developed in this work. 75 references. (auth)

575

Los Alamos Scientific Laboratory
QUANTITATIVE SEPARATION OF AMERICIUM AND PLUTONIUM USING CUPFERRON. J. P. Nigon and R. A. Penneman. [nd.] 8p. (AECU-1006; LADC-793)

Since americium can be formed by successive neutron capture of plutonium, a method for separating the two metals is necessary. The extraction of plutonium(IV) cupferrate with chloroform has been reported previously. Since Am exhibits an extremely stable (III) state, experiments on cupferron separation of mixtures of known ratio were carried out using the differential $\alpha$-energy analyzer to follow the extraction. As little as $^1/_{10}$ $\mu$g of Am could be recovered quantitatively from 10 mg of Pu (a factor of 100,000 in concentration). The effects of added Fe and La and of temperature on the separation are presented.

576

Iowa State College
AN EFFICIENT SEPARATION OF DYSPROSIUM AND YTTRIUM. F. H. Spedding and J. L. Dye. [nd.] 2p. (AECU-1016; Contribution No. 131)

The report is reproduced here in its entirety.

A rapid and efficient separation of the difficultly separable rare-earth pair, dysprosium and yttrium, has been accomplished by elution with 5% ammonium citrate solution at room temperatures on Nalcite H.C.R. resin. This is achieved because of a shift in the order of elution of yttrium relative to the other rare earths. With 0.1% citrate solution, the order of elution is Dy-Y-Tb (Spedding et al., paper presented before the September 1950 meeting of the American Chemical Society in Chicago), while the order observed with 5% citrate is Dy-Tb-Y. Previously it had been reported (Ketelle and Boyd, J. Am. Chem. Soc. 69, 2800(1947)) that elution at 100°C of tracer amounts of rare earths with 5% citrate showed yttrium eluting ahead of dysprosium. When eluting with 5% citrate at pH values greater than 2.8, the rare-earth band immediately precedes the hydrogen band on the column and results in a square-type band front. At lower pH values, the ammonium ions pass the rare-earth ions, and consequently the rare earths are on an ammonium bed. The resultant band front at these lower pH values is sloping, and the elution curves resemble those previously obtained with other rare earths using similar conditions (Spedding et al., J. Am. Chem. Soc. 69, 2777(1949)). At all pH values when 5% ammonium citrate is used as eluant, the observed order of elution is Dy-Tb-Y. A load of 7.6 g of oxides was placed on a column containing 450 g of resin and eluted with 5% citrate. The resin bed length was 60 cm and the diameter was 4 cm. These oxides, obtained by column fractionation of $R_2O_3$ from gadolinite ore, had the composition 10% $Dy_2O_3$, 89% $Y_2O_3$, 0.5% $Ho_2O_3$, 0.5% $Tb_4O_7$. Analyses were made by spectrophotometric and spectrographic methods. At a pH value of 2.80, 85% of the available $Y_2O_3$ was obtained spectrophotometrically pure (>99%). Previous work using 0.1% citrate at pH values of 5.5 to 6.0 eluted less than 10% of the available $Y_2O_3$ with comparable purity. The total time of a run using 5% citrate at a pH of 2.80 is only one-third that required with 0.1% citrate. The concentration of rare earths in the eluate using 5% citrate is correspondingly higher. It appears that the most efficient way to obtain pure $Y_2O_3$ and pure $Dy_2O_3$ from an ore concentrate involves two ion-exchange procedures: (1) first a preliminary elution using 0.1% citrate with pH values between 5.8 and 6.1, which separates dysprosium and yttrium from the other rare earths; (2) elution of the yttrium-dysprosium fractions so obtained with 5% citrate, using a pH value of 2.8, to obtain the pure salts.

577

Los Alamos Scientific Laboratory
MICRO SUBLIMATION OF ORGANIC COMPOUNDS. Arthur Murray III, C. Wayne Bills, and Anthony R. Ronzio. June 2, 1950. 11p. (LA-1119; LADC-890)

A description of equipment and procedures for sublimation in a high vacuum as a purification process is presented. A solution of the compound to be sublimed is placed in the lower half of the sublimator, the solvent is removed by evaporation, and the sublimator is then assembled using "Celvacene-light" grease. The vacuum furnished by a mechanical pump is satisfactory for the majority of sublimations. Heating is accomplished with a wax bath containing an electrical immersion heater which is controlled with variable autotransformer. Sublimation is allowed to take place at the lowest temperature at which the compound sublimes slowly.

578

ION CHARGE AND EXCHANGE RATES WITH ION-EXCHANGE POLYMERS. G. E. Boyd, A. W. Adamson, and L. S. Myers, Jr. J. Am. Chem. Soc. 72, 4807-8(1950) Oct. (Note)

The influence of cationic charge on exchange rates with Amberlite IR-1 ion-exchange resin has been investigated by measuring the uptake from dilute HCl solution at 25°C of $Na^+$, $UO_2^{+2}$, and $Ce^{+3}$ ions as a function of time using radioactive $Na^{24}$, $U^{233}$, and $Ce^{144}$ as tracers. Rate constants for the exchange of these ions are given, and the various kinetic mechanisms are discussed.

## SORPTION PHENOMENA

579

Western Reserve University
ADSORPTION OF METHANE AND ARGON ON TITANIUM DIOXIDE BETWEEN 78° AND 90°. E. L. Heric, Murray Goldstein, and E. L. Pace. Sept. 7, 1950. 13p. (NYO-657)

An adsorption apparatus has been designed which affords ease of both construction and operation. Using this apparatus, the isotherms of methane and argon adsorbed on rutile have been determined. The BET (S. Brunauer, P. H. Emmett, and E. Teller, J. Am. Chem. Soc. 60, 309(1938)) and Huttig (G. F. Huttig, Monatsh. 78, 177(1948)) theories indicate a surface area of from 70 to 100 $m^2/g$. The general shapes of the curves of the isosteric heats of adsorption as determined by the Clausius-Clapeyron equation are described. (auth)

580

Office of Naval Research, London
APPLICATION OF THERMODYNAMICS AND STATISTICAL MECHANICS TO ADSORPTION PROBLEMS. George J. Szasz. Aug. 18, 1950. 13p. (ONRL-84-50)

An informal conference on the "Application of Thermodynamics and Statistical Mechanics to Adsorption Problems" was held at the Chemistry Department, University College, Dundee, Great Britain, on July 20-21, 1950. Monolayer and multilayer adsorption and hysteresis were discussed. In

this report a brief account of some of the papers and discussions is given. The complete program of the discussion is listed.

## SPECTROSCOPY

581

ABSORPTION SPECTRA OF $Nd(NO_3)_3$ IN VARIOUS BINARY SOLVENTS. O. V. Fialkovskaya. Doklady Akad. Nauk S.S.S.R. 74, 469-72(1950) Sept. 21. (In Russian)

Line shifts and changes in relative line intensities in absorption spectra of $Nd(NO_3)_3$ were obtained by changing relative concentrations of components in binary solvents $H_2O$ + methanol, $H_2O$ + acetone, and $H_2O$ + dioxane. Notwithstanding those changes, lines due to each component retain their individuality. It follows that the foregoing binary mixtures behave more like emulsions than solutions (see Meyer, Phys. Rev. 35, 291(1930)). While some Nd ions are surrounded by molecules of the organic solvent and stand in a purely electrostatic relation to the neighboring medium (reflected in a simple dependence of the line shift on the dielectric constant), other Nd ions are surrounded by molecules of water and determine more complex hydration effects.

582

THE RAMAN SPECTRUM OF TETRAFLUOROETHYLENE IN THE CONDENSED PHASE, WITH FURTHER ASSIGNMENT OF THE FUNDAMENTAL FREQUENCIES. André Monfils and Jules Duchesne. J. Chem. Phys. 18, 1415(1950) Oct. (Letter to the editor)

The following Raman frequencies in $cm^{-1}$ of liquid $C_2F_4$ at $-100°C$ have been found: 397(m), 508(vs), 551(m), 779(s), 830(w), 930(vvw), 1018(vw), 1100(vw), 1350(vvw), and 1872(m). These data are accurate to $\pm 1$ $cm^{-1}$ for the strong lines and to $\pm 3$ $cm^{-1}$ for the weak ones. A comparison with the infrared bands shows that there are no coincidences. This fact, which depends on the selection rules for the $V_h$ point group, favors $V_h$ symmetry in the liquid as well as in the gas. On the basis of a comparison of these data with the Raman spectrum of the gaseous phase, the plane frequencies have been assigned as follows: $A_g$, 397, 779, 1872; $B_{1g}$, 1100, 551; $B_{3u}$, 1186, 558; $B_{2u}$, 1337, 250 $cm^{-1}$. The C=C frequency vibration at 1872 $cm^{-1}$ is strikingly higher than the corresponding vibration in $C_2H_4$ (1623) and $C_2Cl_4$ (1571). This fact is in agreement with preliminary calculations of the C=C bond force constant for $C_2F_4$.

## SYNTHESES

583

Argonne National Laboratory
THE EXCHANGE OF LITHIUM HYDRIDE WITH TRITIUM; THE PREPARATION OF LITHIUM ALUMINUM TRITIDE. Louis Kaplan and K. E. Wilzbach. [nd.] 3p. (AECD-2953; ANL-WMM-707)

Tritium-labeled lithium aluminum hydride would be very useful for the introduction of tritium into specific positions in organic molecules. Since lithium aluminum hydride is readily prepared from lithium hydride and aluminum chloride, a study has been made of the feasibility of obtaining lithium hydride-t by the exchange reaction of lithium hydride with tritium gas. The exchange has been found to take place at a useful rate at temperatures above 200°C and at a measurable rate even at room temperature. Lithium hydride-t, prepared in this manner, has been converted to lithium aluminum hydride-t, and the latter has been used successfully for the reduction of ethyl acetate to ethanol-1-t.

584

Los Alamos Scientific Laboratory
MICRO SYNTHESES WITH TRACER ELEMENTS; XVIII. THE SYNTHESIS OF $C^{14}$-LABELED FORMALDEHYDE OF HIGH SPECIFIC ACTIVITY. Arthur Murray III, and Anthony R. Ronzio. [nd.] 10p. (AECU-991; LADC-778)

Catalytic air oxidation of $C^{14}$-labeled methanol using a molybdenum oxide–ferric oxide catalyst gave predictable and uniform yields and high specific activity of $C^{14}$-labeled formaldehyde. 5 figures.

585

Los Alamos Scientific Laboratory
MICRO SYNTHESES WITH TRACER ELEMENTS. XXIV. THE SYNTHESIS OF BENZYL ALCOHOL LABELED WITH $C^{14}$. C. Wayne Bills and Anthony R. Ronzio. [nd.] 4p. (AECU-1005; LADC-881)

A sample of labeled benzyl alcohol was desired as an intermediate in the synthesis of toluene and anthracene. The electrolytic reduction of benzoic acid as studied by Mettler (Ber. 38, 1748(1905)) and Swann and Lucker (Trans. Electrochem. Soc. 75, 411(1939)) offered the most convenient method for the preparation of the compound, and is here reported. $C^{14}$-benzoic acid was prepared by the Grignard reaction method of Dauben et al. (Anal. Chem. 19, 828(1947)), Somewhat higher yields of acid were obtained than those reported.

586

University of California Atomic Energy Project, Los Angeles
EXPLORATORY STUDIES ON A NEW GENERAL SYNTHESIS OF STRAIGHT-CHAIN MONO-ENOIC FATTY ACIDS. Harry M. Walborsky and David R. Howton. Nov. 17, 1950. 17p. (UCLA-98)

A new synthesis in which $\omega$-haloacetals are condensed with sodium 1-alkynides to give straight-chain acetylenic acetals has been devised and shown to be applicable to the preparation of the ethylene-glycol acetal of 4-octynal. By suitable stereospecific semireductions, this acetal can be converted to the corresponding cis- or trans-olefinic substances. It has also been demonstrated that the acetylenic acetal can be hydrolyzed to the corresponding free aldehyde, and that this, in turn, can be oxidized in good yield to the analogous carboxylic acid. (auth)

587

CHEMICAL PREPARATION OF ASYMMETRICALLY LABELED CITRIC ACID. Philip E. Wilcox, Charles

Heidelberger, and Van R. Potter. J. Am. Chem. Soc. 72, 5019-24(1950) Nov.

Asymmetric sodium citrate-1-$C^{14}$ has been prepared by the reaction of $NaC^{14}N$ with levorotatory $\gamma$-chloro-$\beta$-carboxy, $\beta$-hydroxybutyric acid, a new compound. The labeled citric acid was carefully characterized and subjected to the enzymatic action of a fortified rat liver homogenate. The $\alpha$-ketoglutaric acid which was isolated from the homogenate was found to carry the isotope entirely in the $\gamma$-carboxyl group. These results prove that the asymmetric distribution of isotope in the carboxyl groups of $\alpha$-ketoglutaric acid which is found in studies of Krebs' citric acid cycle arises from an asymmetric configuration (of the isotope) in the citric acid and an antipodal specificity of the enzymes which catalyze the formation and the dehydration of citric acid. The enzymatic reactions are discussed in terms of the stereochemical properties of symmetric molecules which are asymmetrically labeled. (auth)

## TRANSURANIC ELEMENTS AND COMPOUNDS

588

Argonne National Laboratory
THE ENTROPY AND LOW-TEMPERATURE HEAT CAPACITIES OF NEPTUNIUM DIOXIDE. E. F. Westrum, Jr., J. B. Hatcher, and D. W. Osborne. July 28, 1950. Decl. Sept. 1, 1950. 18p. (AECD-2863; ANL-EFW-34)

The availability of a sample of approximately 2 g of pure neptunium dioxide has made possible the measurement of the low-temperature heat capacities of this compound. To carry out the investigation on such a small amount of material, an adiabatic semimicrocalorimeter and a cryostat were constructed. The cryostat employs only liquid nitrogen and liquid helium as refrigerants for measurements in the range 4 to 320°K. No liquid hydrogen is necessary. 3 figures. (auth)

589

Los Alamos Scientific Laboratory
A NEW VALENCE STATE OF AMERICIUM, Am(VI). L. B. Asprey, S. E. Stephanou, and R. A. Penneman. [nd.] 2p. (AECD-2950; LADC-739)

The report is reproduced here in its entirety.

The following evidence has been obtained for the existence of americium in the formal valence of plus six: (1) Americium(III) is completely oxidized by ammonium peroxydisulfate in 0.2M nitric or perchloric acids to a nonfluoride-precipitable state. At a concentration of 200 $\mu$g of element per 100 microliters (2 g/l), the characteristic pink of Am(III) changes to a strong yellow color. (2) The absorption spectrum of such an oxidized solution was measured with a Beckman model DU spectrophotometer using quartz microcells and 0.1 sensitivity scale. The solution shows no Am(III) absorption at 504 and 811 m$\mu$, or Am(V) absorption at 514 and 714 m$\mu$. There is a narrow and prominent peak at 991-992 m$\mu$, and a strong ultraviolet absorption. The decrease with time of these new absorption peaks is attended by a growth of Am(V) absorption but no increase in the Am(III) absorption. The rate of decrease of the 991 peak is much greater in the absence of sulfate, and the ultraviolet absorption is altered. (3) By the addition of sodium acetate, a yellow compound of tetrahedral structure was obtained which was isomorphous with the analogous $NaMO_2Ac_3$ compounds (M is U or Pu). The refractive index of sodium americyl acetate has the expected value of 1.528 (compared with 1.501 and 1.518 for the uranium and plutonium compounds, respectively). There were no Am(III) or Am(V) absorption lines in this compound. The compound was dried with acetone, treated with excess ferrous ammonium sulfate, and back-titrated with ceric sulfate. The amount of americum was determined by radioassay. A value of 2.9 was obtained for the number of equivalents on reducing Am(VI) to Am(III). (4) X-ray analysis showed a cubic structure with an $a_0$ of 10.6 which is the same as that of the uranium and plutonium analogs. (5) Ether extraction after removal of sulfate with barium and salting with ammonium nitrate and nitric acid gave essentially complete extraction. (6) Hexone (methyl isobutyl ketone) was also successful, but less complete, apparently owing to reduction by the solvent. (7) Addition of sulfuric acid (sufficient to make 4M $H_2SO_4$) to a solution of Am(V) in 0.3M $HClO_4$ caused rapid disappearance of Am(V) absorption which was accompanied by a rapid growth of the 991 peak (Am(VI)) and Am(III) absorption. Insufficient evidence has been accumulated to establish whether this disproportionation gives Am(IV) in observable amounts.

590

Argonne National Laboratory
SPECTROPHOTOMETRY OF NEPTUNIUM IN PERCHLORIC ACID SOLUTIONS. R. K. Sjoblom and J. C. Hindman. Apr. 14, 1950. 36p. (ANL-4443)

Details of the absorption spectra of the neptunium(III), (IV), (V), and (VI) ions in 1M perchloric acid are given. The principal bands have been tested for adherence to the Beer-Lambert law. Vibrational fine structure has been found in the absorption spectra of Np(V) and Np(VI). As for U(VI) and Pu(VI), this fine structure is interpreted as being due to symmetrical metal-oxygen vibrations in ions of the type $NpO_2^+$ and $NpO_2^{++}$. The vibrational frequency of the Np(V) ion is 753 $cm^{-1}$ and that of the Np(VI) ion is 715 $cm^{-1}$ in 1M $HClO_4$. The interpretation of effect of change in perchloric acid concentration on the absorption spectra of the ions of the various oxidation states is discussed. Preliminary data on the disproportionation reaction $2Np(V) \rightleftharpoons Np(IV) + Np(VI)$ which has been found to occur in concentrated perchloric acid solutions is given. (auth)

## URANIUM AND URANIUM COMPOUNDS

591

Argonne National Laboratory
STUDIES ON THE URANIUM-OXYGEN SYSTEM. H. R. Hoekstra and J. J. Katz. Aug. 10, 1950. Decl. Oct. 17, 1950. 15p. (AECD-2954; PC-1240)

The uranium-oxygen system is complicated by the existence of a multiplicity of crystalline forms and extensive regions of solid solution, with both reversible and irreversible decomposition regions. The present paper discusses that portion of the system extending from $UO_3$ down to $UO_2$.

After reviewing the conflicting phase relations found in the literature, the authors report some experimental studies on the phase systems of oxygen with Mg, Ca, Sr, and Ba diuranates and on the thermal decomposition of the crystalline phases of $UO_3$. Similarities between the alkaline earth diuranate and the uranium-oxygen systems are shown, and some thermodynamic data on the phase transformations are presented.

592

DETERMINATION OF SMALL AMOUNTS OF URANIUM. I. A CRITICAL DISCUSSION OF METHODS PREVIOUSLY USED AND A GENERAL SURVEY OF THE PRESENT INVESTIGATION. Gustaf Ljunggren, Roland Rynninger, and Lars Gunnar Sillen. Svensk Kem. Tid. 61, 170-80(1949).

The object of this first paper of a series is to outline an investigation into the problem of rapidly, easily, and routinely determining uranium in concentrations as small as 0.001%, to within 0.001%, and in the presence of large quantities of interfering elements. The literature on various uranium analytical methods is reviewed briefly, and the choice of a suitable method is discussed. The proposed experimental work is then outlined.

593

DETERMINATION OF SMALL AMOUNTS OF URANIUM. II. PRELIMINARY EXPERIMENTS ON THE ETHER EXTRACTION METHOD. Karin Lindh, Roland Rynninger, and Else Skaraeus. Svensk Kem. Tid. 61, 180-8(1949).

By extraction with ether even small amounts of uranyl nitrate can be separated quantitatively from solutions containing large amounts of other elements, especially Fe, even up to a weight ratio U : Fe of 1 : 25,000. The efficiency of the extraction is influenced by the concentration of nitrate ions and free nitric acid. The minimum time required for extraction has been determined using a special type of apparatus. Two colorimetric methods for determination of U have been studied with special regard to their application to an ether extract. The colorimetric determination of U with $H_2O_2$ in sodium carbonate solution has proved applicable, whereas the salicylate reaction of U in ammoniacal solution is interfered with by Fe even in amounts of 0.02 mg/l, which may easily remain in the extract from solutions of strong Fe concentration.

594

DETERMINATION OF SMALL AMOUNTS OF URANIUM. III. FURTHER INVESTIGATIONS ON THE ETHER EXTRACTION METHOD AND DEVELOPMENT OF A GENERALLY APPLICABLE PROCEDURE. Barbro Helger and Roland Rynninger. Svensk Kem. Tid. 61, 189-96(1949).

In order to find a generally applicable method, based on ether extraction, for the determination of small amounts of uranium, different kinds of decomposition were studied. For decomposing rock samples treatment with HCl and $HNO_3$ and decomposition of the insoluble residue with $HNO_3$ and HF acids is as a rule satisfactory. Metallurgical slags and similar products must be sintered with sodium peroxide and sodium carbonate. Sulfates and phosphates were found to interfere with the ether extraction and must be removed. Precautions must be taken to prevent losses caused by reduction of uranyl to quadrivalent uranium. The methods for final determination by precipitation with oxine and colorimetric determination with cyanoferrate have been studied and modified. (An abstract of the final paper, Part IV, of this series appears in NSA as abstract 4-1112.)

# ENGINEERING

## HEAT TRANSFER

595

Babcock and Wilcox Co. and NEPA Division
EROSION AND HEAT TRANSFER WITH LIQUID METALS; PROGRESS REPORT I COVERING THE PERIOD PRIOR TO JANUARY 16, 1950. H. G. Elrod, Jr., and R. R. Fouse. 1950. 11p. (NEPA-1270)

The objectives and proposed organization for research on heat transfer by bismuth and erosion by liquid lithium are briefly reported. An analysis of experimental possibilities has been made, and tentative proposals for investigations are reached.

596

Stanford University
HEAT TRANSFER AND FLOW FRICTION CHARACTERISTICS OF POROUS SOLIDS. G. L. Locke. June 1, 1950. 112p. (NP-1757; Technical Report No. 10)

The work accomplished to date on an investigation of the convective heat-transfer and friction characteristics for flow through porous solids such as packed screens and beds of granular materials is summarized. A mathematical analysis is presented for the determination of the temperature of the solid and fluid as a function of time and position for two transient conditions: (a) heating of the solid with a distributed heat source when a cool fluid is flowing through, and (b) cooling of the solid when the heat source is switched off. An experimental method and apparatus are described for measuring the friction factor and convective heat-transfer coefficient of material such as porous solids; for the heat-transfer data, conventional steady-state techniques are not applicable. An appraisal of the accuracy and errors indicates that the results obtained will have an expected uncertainty of ±13% in the heat-transter coefficient and ±3% in the friction factor. Preliminary experiments on a straight tube test core verifies the practicality of the method for testing porous solids and also for testing any type of core which because of high effectiveness cannot be tested by the usual steady-state method. (auth)

597

Knolls Atomic Power Laboratory
STRESSES IN LONG, THIN-WALLED CYLINDERS, DUE TO AN AXIAL TEMPERATURE GRADIENT. G. Horvay and W. P. Manger. Aug. 15, 1950. 26p. (KAPL-390)

Curves are presented which permit rapid determination of the stresses and deflections in long thin-walled cylinders caused by sinusoidal or exponential axial temperature variations. A problem and its solution, derivation of pertinent equations with an analysis leading to the equation of a beam on an elastic foundation, and solution of this equation (conforming to assumed boundary conditions) are included.

### MATERIALS TESTING

598

National Bureau of Standards
CREEP TESTS ON GRAPHITE. M. D. Burdick. Feb. 21, 1950. 6p. (NEPA-1318)

Tests in air of a group of four coated graphite specimens are nearly completed. These tests indicate that a silicon carbide coating of 30 to 35 mils thickness may, in some cases, give suitable protection for creep tests in air. However, the strength and rigidity of the coating material apparently mask the creep characteristics of the under body. It would appear that more data on the creep of graphite could be obtained either by testing uncoated specimens in helium or by testing very thinly coated specimens in helium. Three tests of uncoated specimens have been made during the month. When the specimens were examined after failure, varying amounts of deterioration were noted.

599

CREEP IN A PRECIPITATION-HARDENED ALLOY. M. Davis and N. Thompson. Proc. Phys. Soc. (London) 63B, 847-60(1950) Nov. 1.

Measurements have been made of the creep shown by polycrystalline wires of a hardened alloy (Cu + 3% Ag) both at room temperature and 90°K. The results are interpreted in terms of the Mott-Nabarro theory of transient creep. The agreement between theory and experiment is qualitatively good, and the quantitative discrepancies suggest directions in which the existing theory might be refined. (auth)

600

SURFACE EFFECTS IN CREEP OF CADMIUM CRYSTALS. D. J. Phillips and N. Thompson. Proc. Phys. Soc. (London) 63B, 839-47(1950) Nov. 1.

A recording rate-of-strain meter has been used to investigate the changes in creep rate when the chemical environment of a stressed cadmium crystal is altered. Experiments were made with aqueous solutions of a number of inorganic salts of cadmium. The observations are explicable in terms of variations in the thickness of a surface film of cadmium hydroxide, the presence of such a film having the effect of reducing the creep rate by an amount depending on its thickness. Measurements were also made on the effect of very thin films, formed by immersion in distilled water; these were estimated to be about $10^{-8}$ to $10^{-7}$ cm thick. When the films were removed with dilute sulfuric acid a sudden small strain increment was observed, the magnitude of which depended on the film thickness. Possible explanations are discussed. (auth)

### PUMPS

601

Atomic Energy Research Establishment
A REFRIGERATOR-COOLED TWO-INCH DIFFUSION PUMP. R. S. Barton. Sept. 1950. 21p. (AERE-G/R-565)

The performance of a Metropolitan Vickers Type 03B diffusion pump was determined at various heater wattages and cooling-jacket temperatures. Similar investigations were made using a Type 03B pump with its cooling system adapted for chilling by a refrigerant gas. During the investigation, random fluctuations of the fine-side pressure were observed, and the technique adopted for the removal of these is described. (auth)

# MINERALOGY, METALLURGY, AND CERAMICS

### CERAMICS AND REFRACTORIES

602

ON THE PROBLEM OF PREPARING MONOCRYSTALS OF BORON CARBIDE. I. L. Zagyanskiĭ, G. V. Samsonov, and N. V. Popova. Doklady Akad. Nauk S.S.S.R. 74, 723-4(1950) Oct. 1. (In Russian)

Boron carbide $B_4C$, one of the hardest substances in existence (second only to diamond) and a very brittle one, has been known in minute crystals only. Using a mixture of boron oxide and carbon black, rather large crystals of about $10 \times 10 \times 0.5$ mm were obtained at the electrode of a resistance furnace, the heating being followed by a very prolonged cooling. It was essential to provide hollow recesses in the vicinity of the electrodes. It is probable that in the hollow between the electrode and the crust of finely crystallized carbide, a dissociation of $B_4C$ into boron gas and a liquid rich in carbon took place; during the cooling, $B_4C$ formed from the two phases and slowly crystallized. The crystals are dark and opaque.

### METALS AND METALLURGY

603

Westinghouse Atomic Power Division
PREFERRED ORIENTATION IN ZIRCONIUM. R. K. Mc-

Geary and B. Lustman. Mar. 10, 1950. (Decl. Oct. 16, 1950) 35p. (AECD-2951; WAPD-8)

The preferred orientation produced in zirconium when subjected to the following treatments has been investigated: various types of cold-rolling deformation, cross-rolling, hot-rolling, recrystallization below the transformation temperature, and heating above the transformation temperature. Crystal-bar and ingot zirconium show very similar textures. All these textures of zirconium differ fundamentally from those of magnesium and beryllium, the other close-packed hexagonal metals of similar axial ratio. The cold-rolling and hot-rolling textures are similar, although the cold-rolled material has a much sharper orientation then the hot-rolled material. Cross-rolling produces a different texture than is produced by other rolling deformations. The deformation textures change to new textures when the material is heated so as to cause recrystallization. The crystallographically reversible phase transformation of zirconium causes a new type of preferred orientation when the metal is heated above the $\alpha$-$\beta$ transformation temperature. (auth)

604

National Bureau of Standards
HEAT CAPACITY OF POTASSIUM AND THREE POTASSIUM-SODIUM ALLOYS BETWEEN 0° AND 800°C. Thomas B. Douglas, Anne F. Ball, and Defoe C. Ginnings. [nd.] 30p. (AECU-1017)

Using the drop method and an ice calorimeter, as with earlier experiments with sodium, measurements have been made of the changes in enthalpy in the range 0 to 800°C of potassium and three sodium-potassium alloys containing approximately 45, 54, and 78% by weight of potassium. The measurements on the first two alloys were of precision inferior to the 0.05% or better usually obtained with this apparatus, owing to the complication of a solid-phase transformation in the process of cooling. The heat capacities of solid and liquid potassium, the heat of fusion of potassium, and the heat capacities of the three alloys in the liquid state were derived from the enthalpy measurements. The heat capacities of the liquid alloys were found to correspond very closely at each temperature between 100 and 800° with those calculated additively from the values found for pure liquid potassium and sodium. As reported earlier for liquid sodium, all the liquids show a minimum in heat capacity at 500 to 600°C. (auth)

605

M.I.T. Department of Metallurgy
FOURTH INFORMAL MONTHLY REPORT ON DEVELOPMENT OF METAL-CERAMIC COMPOSITIONS SUITABLE FOR SERVICE AT ELEVATED TEMPERATURES. W. D. Kingery, G. Economos, M. Humenik, Jr., and M. Berg. Nov. 1949. 7p. (NEPA-1234)

Assembly of the sessile-drop horizontal-tube induction furnace has been completed, and testing of the furnace is under way. A drawing of the furnace chamber is included. It was found impossible to support adequately a capillary in a crucible of molten metal by means of tantalum or platinum wire. In the formation of capillaries by casting about nylon fibers, it was found necessary to remove the fiber prior to firing. Approximate contact angles for iron with stabilized zirconia were determined. A literature study indicates that no reliable values for the surface tension of metals is available above 1500°C. Widely divergent values are encountered for lower-melting-point metals. Surface tension of liquids is known to vary greatly with certain impurities; the effect of impurities on the surface energy of solids is not known; surface roughness is believed to affect the apparent contact angle. (auth)

606

Oak Ridge National Laboratory
THE CORROSION RESISTANCE OF VARIOUS STAINLESS STEELS IN AQUEOUS SOLUTIONS IN THE PRESENCE OF DOWEX NO. 50 RESIN. Arnold R. Olsen. Sept. 15, 1950. 17p. (ORNL-804)

Since many reactions involving ion-exchange resins take place in corrosive media, corrosion of the resin containers becomes a problem. Tests were made to determine the comparative corrosion resistance of stainless steel Types 304, 309, 316, 347, 410, and 430, when exposed to Dowex No. 50 resin saturated with distilled water, 6M $HNO_3$, and 5% oxalic acid for 2- and 4-month periods. The results indicate that Type 304 and Type 347 be used for unwelded and welded containers, respectively. The penetration rate for these steels is less than 0.12 mil per year.

607

Oak Ridge National Laboratory, Y-12 Area
INVESTIGATION OF SOME OF THE OPTICAL PROPERTIES OF ZIRCONIUM AND HAFNIUM COMPOUNDS. T. N. McVay. Sept. 5, 1950. 8p. (Y-668)

The optical properties of zirconium tetrafluoride and hafnium tetrafluoride were determined. Some samples purporting to be zirconium oxyfluoride and hafnium oxyfluoride were shown to be mixtures, and the refractive indices of some of the other crystals present, other than the tetrafluorides, are given. Directions for optical examination of these samples are detailed.

608

Lewis Flight Propulsion Laboratory
BONDING INVESTIGATION OF TITANIUM CARBIDE WITH VARIOUS ELEMENTS. Walter J. Engel. Sept. 1950. 15p. (NACA-TN-2187)

Of 15 elements individually fused on solid high-density titanium carbide at minimum fusion temperatures in a helium atmosphere and at atmospheric pressure, only Ni, Co, Cr, and Si produced bonds with titanium carbide. Metallographic studies of the interface between the element and the titanium carbide in the four bonds indicated that Ni and Co appeared to produce extensive interlocking bonds, with nickel showing the greater penetration. The observed interfaces provided information concerning some of the reactions involved in bonding of elements to solid titanium carbide. The 11 elements that did not bond with titanium carbide under the conditions in this experiment were: Al, Be, Nb, Au, Fe, Pb, Mg, Mn, Pt, Ti, and V. (auth)

609

National Bureau of Standards
COMPARISON OF FATIGUE STRENGTHS OF BARE AND ALCLAD 24S-T3 ALUMINUM-ALLOY SHEET SPECIMENS TESTED AT 12 AND 1000 CYCLES PER MINUTE. Frank C. Smith, William C. Brueggeman, and Richard H. Harwell. Dec. 1950. 18p. (NACA-TN-2231)

The results of axial fatigue tests conducted on 0.032-in.-thick flat-sheet specimens of bare and alclad 24S-T3 aluminum alloy to determine the effect of frequency of loading on the fatigue strengths of these materials are described. The number of cycles to failure varied from about 150 to more than 10,000,000. Tests were conducted using completely reversed axial load at two frequencies of loading: 12 and 1000 cycles/min. The tests showed that the fatigue strengths of the materials were slightly less when tested at 12 cycles/min. For those specimens which were stressed into the plastic range an investigation was made of the variation of maximum stresses and mean stresses with repeated loading.

610

University of California Institute of Engineering Research
THE EFFECT OF ALLOYING ELEMENTS ON THE ELECTRICAL RESISTIVITY OF ALUMINUM ALLOYS. A. T. Robinson and J. E. Dorn. Aug. 15, 1950. 21p. (NP-1797; Tenth Technical Report)

The effect of alloying additions of Cu, Zn, Ge, Ag, Cd, and Mg to aluminum on its electrical resistivity has been determined. Applying the Norbury rule to the resistivity of aluminum alloys suggests that the apparent valence of aluminum is approximately 2.5. (auth)

611

University of California Department of Engineering
FUNDAMENTAL STUDIES RELATED TO THE ORIGIN AND NATURE OF CREEP OF METALS; FIRST TECHNICAL REPORT. CREEP AS A SURFACE-DEPENDENT PHENOMENON. Milton R. Pickus, Earl R. Parker, L. O. Seaborn, and E. Henderson. July 1950. 38p. (NP-1667)

Comparative creep tests are described for single-crystal and polycrystalline zinc, with and without the presence of a surface layer containing electrodeposited copper. For polycrystalline zinc, neither the creep rate at constant temperature and load nor the temperature dependence of the creep rate at constant load was affected by the presence of copper in the surface layer. The single crystals showed a marked increase in the resistance to creep as a result of the electrodeposited copper layer. The copper also caused an increase in the temperature dependence of the creep rate, suggesting that a higher activation energy is required to generate dislocations when copper is present in the surface layer. The temperature dependence of the creep rate was the same for unplated single crystals and for polycrystalline zinc. This may indicate that for zinc, dislocations can be generated at grain boundaries just as readily as at the external surface. The copper-plated zinc single crystals developed a new type of internal boundary that followed the contour of the glide ellipse near its edge. The possible role of this boundary in contributing to the observed strengthening effect of the copper deposit is discussed. A study was made of the steady-state creep behavior of "A" nickel in different environments and surface conditions. Resistance to high-temperature creep was much greater in air than in either purified hydrogen or nitrogen. The presence of tungsten in the surface layer did not affect the resistance to creep. In regard to the temperature dependence of steady-state creep, "A" nickel was insensitive to conditions at the surface. An important conclusion resulting from this work is the fact that under certain conditions, creep is a surface-dependent phenomenon, and, moreover, that surface effects such as those hitherto reported only for single crystals of metals like zinc, cadmium, and tin may also occur in polycrystalline high-temperature metals such as nickel.

612

Office of Naval Research, London
METALLURGICAL RESEARCH AT CAMBRIDGE UNIVERSITY. B. D. Cullity. [nd.] 5p. (ONRL-94-50)

Some of the metallurgical investigations in progress in the Metallurgy Department and in the Cavendish Laboratory at Cambridge University, England, are briefly reported. The high-speed compression of aluminum, transient creep of copper, deformation bands in aluminum, crystal structure of the sigma phase, mechanism of gas chromizing (deposition of Cr on Fe from a $CrCl_2$-$H_2$ atmosphere), and internal oxidation of copper alloys are being studied.

613

North American Aviation, Inc.
PREPARATION AND COUNTING OF COPPER-GOLD (+ $Au^{198}$) SPECIMENS FOR DIFFUSION STUDIES. Frank Asaro. Aug. 28, 1950. 27p. (NAA-SR-85)

Satisfactory Cu-Au (enriched with $Au^{198}$) specimens for diffusion studies were prepared by electroplating from $Au^{198}$-enriched solutions, with and without added carrier. The procedure followed is described in some detail. Estimates are presented of the chemical and electrochemical processes involved. After heating to specific temperatures to permit diffusion, the Cu-Au specimens were prepared for dip counting by sectioning, dissolving in hot aqua regia, and diluting the resulting solutions to a standard volume. 11 figures. (auth)

614

PRODUCTION OF MALLEABLE ZIRCONIUM ON A PILOT-PLANT SCALE. W. J. Kroll, W. W. Stephens, and H. P. Holmes. J. Metals (N.Y.) 188, 1445-53(1950) Dec.

A pilot plant producing 600 lb of zirconium sponge a week is described. It comprises an arc furnace to make zirconium carbide, a chlorinator producing raw chloride, a purification vessel to eliminate zirconium oxide and iron from this chloride, two reduction vessels, two vacuum retorts for salt separation, and a graphite resistor vacuum furnace to melt ingots. A layout of the plant, power consumption, operation schedules, and production costs are given. (auth)

615

New Mexico School of Mines
I. STUDY OF THE SULFIDES OF INDIUM; II. STUDY OF

INDIUM (III) CHLORIDE COMPLEXES BY POLAROGRAPHIC METHODS. M. F. Stubbs and J. A. Schufle. Sept. 1950. 33p. (NP-1829; Technical Report No. 1)

A study has been made of the In-S system by means of thermal analysis and metallography. A phase diagram has been worked out and is presented. The compounds $In_2S_3$ and InS have been found to exist, and possibly $In_3S_4$ and $In_5S_6$, but not the previously reported $In_2S$. The oxidation of $In_2S_3$ in the air has been studied at carefully controlled temperatures. No evidence of the conversion of $In_2S_3$ to InS, as previously reported, has been found. The polarographic reduction of indium(III) ions in solutions of hydrochloric acid has indicated the existence of two indium(III) chloride complexes, $InCl_4^-$ and $InCl_2^+$. The polarographic reduction of indium perchlorate in perchloric acid solution, previously reported to be an irreversible reaction, has been found to proceed reversibly. (auth)

616

Bureau of Mines Northwest Electrodevelopment Laboratory, Albany
ZIRCONIUM ALLOY INVESTIGATIONS. 1950. 13p. (NP-1796)

Thermal analysis studies of the zirconium-titanium system give results which are in substantial agreement with data obtained with iodide-deposited alloys, although the transition temperatures for alloys made from magnesium-reduced metal are approximately 20°C higher. The solubility of silicon in $\alpha$ or $\beta$ zirconium is low, and the system is quite complex. Additions of silicon above 0.10% result in increasing amounts of an insoluble second phase which finally reaches such proportions that alloys above 3% are unworkable. Hardness measurements reveal a sharp drop in hardness for all compositions when quenched from 1000°C. X-ray analysis indicates a limited solubility up to 0.5% silicon. Zirconium-chromium alloys prepared with Goldschmidt-reduced chromium reveal microstructures that are dissimilar to those obtained with alloys prepared from electrolytic chromium. The presence of oxygen is believed to be responsible for this variation. A new series with electrolytic chromium additions is being prepared. (auth)

## MINERALS AND MINERALOGY

617

Department of Mines and Technical Surveys, Mines Branch, Ottawa
FLOTATION OF ACID CONSUMING MINERALS FROM ORE 101-B. W. A. Gow. Mar. 1950. 10p. (NP-1597; Topical Report No. 40)

Details of tests to determine the feasibility of floating a higher percentage of carbonate minerals from uranium ore at a coarser grind, without using sodium silicate, and with a lower reagent consumption are reported. The effects of various flotation agents, presence of soda ash, size of grind, pulp modifiers, and supplementary frothers are discussed.

# PHYSICS

618

Oak Ridge National Laboratory
QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 15, 1950; PHYSICS DIVISION. A. H. Snell, Director; E. O. Wollan, Associate Director. Oct. 4, 1950. 96p. (ORNL-782)

Scintillation Spectrometry. Thallium-activated NaI gives very satisfactory performance as a phosphor, and $\gamma$ spectra have been obtained with it from 330-day Cd, $Hg^{203}$, $Cs^{137}$, $Co^{60}$, $K^{42}$, $Na^{24}$, $Cu^{64}$, and a Po-Be-$B_4C$ neutron source ($C^{12}$ excited state at 4.4 Mev). The $K^{40}$ $\gamma$ ray was remeasured at 1.46 ± 0.01 Mev; fewer than two positrons are emitted per $10^5$ $\beta$ particles. The existence of a natural activity in lanthanum is confirmed, but a reported activity in cerium appears to arise from thorium contamination.

Short-lived Isomers. A metastable level of $Ir^{191}$ with a half-life of $5.7 \times 10^{-9}$ sec has been discovered and studied.

The Total Cross Section of Holmium. Holmium has been found to have the rather large cross section of 16 barns for paramagnetic scattering at 0.03 ev.

Neutron Diffraction. Observations on the directional intensity of magnetic scattering from powdered $Fe_3O_4$ have confirmed predictions of the Halpern-Johnson theory, as opposed to predictions of Bloch and Eckstein. An investigation of Fe-Cr alloy has failed to reveal a superlattice; the alloy structure appears to be disordered. Chromium is found to scatter with positive phase and with a cross section of 1.7 barns. Uranium dicarbide is found to have a crystal structure similar to that of calcium carbide.

Low Temperatures. In the nuclear alignment work, the susceptibility of manganous ammonium sulfate has been studied as a function of H. The object of the measurements was to obtain information about the limiting magnetic field below which demagnetization in the main experiment would result in a loss of nuclear alignment through loss of alignment of the electronic magnetic vector.

Irradiation of Semiconductors. Pile irradiation of copper oxide rectifiers leads to a rapid decrease in conductivity in the forward direction, until a value corresponding to that of the backward direction is approached. Preliminary experiments indicate that it may be possible to transform N-type germanium semiconductors into intrinsic semiconductors by introducing just the right number of gallium impurity atoms by transmutation with neutrons.

Properties of Bonded Wire Resistance Strain Gauges. A report is given on the techniques and usefulness of bonded wire strain gauges in measurements of thermal expansion coefficients. For accurate measurements, a variety of precautions must be observed in their use.

Theoretical Physics. Work on the effect of the finite size of the nucleus upon $\beta$ decay has continued, and, although numerical results are not yet at hand, it is apparent that

the effect may be appreciable for some transitions in the heavier elements (Z > 60), revealing itself in a modification of ft values and in the shape of the spectrum.

619

University of California Radiation Laboratory
SUMMARY OF THE RESEARCH PROGRESS MEETING OF SEPTEMBER 21, 1950. Henry P. Kramer. Oct. 3, 1950. 7p. (UCRL-933)

600-in. Radar Telescope. W. W. Salisbury. The construction of a giant 600-in. cast aluminum dish for a radar telescope was described.

Snouting the Beam. Kenneth Relf. A magnetic deflector of 5% efficiency has been constructed to deliver a ½-$\mu$a beam of molecular hydrogen outside the water shield of the 60-in. cyclotron.

Fission of the Medium Weight Elements. Roger Batzel. The excitation function of the two reactions $Cu^{63,65}(p,?)Cl^{38}$ and $Cu^{63,65}(p,?)Na^{24}$ was measured in the energy interval from 0 to 350 Mev. The results are sketched in a diagram. The hypothesis that the reactions proceed by the successive emission of $\alpha$ particles was tested and found to be untenable since the threshold for such a reaction in the case of the transmutation from copper to chlorine is 114 Mev = 59 Mev (binding energy) + 55 Mev (Coulomb barrier) and for the transmutation from copper to sodium 171 Mev = 101 Mev (binding energy) + 70 Mev (Coulomb barrier), and these values exceed the observed threshold by considerable margins. The inescapable conclusion, therefore, is that larger units than $\alpha$ particles are emitted, that is, that "fission" occurs.

620

Office of Naval Research, London
INTERNATIONAL THEORETICAL PHYSICS CONFERENCE ON FUNDAMENTAL PARTICLES AND NUCLEI, PARIS, APRIL 24-29, 1950. Gordon F. Hull, Jr. Aug. 29, 1950. 10p. (ONRL-91-50)

An international conference on theoretical physics of elementary and nuclear particles was held at the Institut Henri Poincaré in Paris, April 24-29. A large number of papers were given by theoretical physicists from Europe and the United States on various aspects of theories of elementary particles. All papers given are title-listed, and the information presented in the fields of quantum electrodynamics, meson theory, evidence for neutral mesons, detection of the neutrino, and the photodisintegration cross section of the deuteron is briefly reviewed.

621

Office of Naval Research, London
PHYSICAL CHEMISTRY RESEARCH AT KING'S COLLEGE, NEWCASTLE-UPON-TYNE. George J. Szasz. Aug. 18, 1950. 5p. (ONRL-83-50)

Some of the current research activities in the Department of Physical Chemistry at King's College, Newcastle-upon-Tyne, are briefly described. Professor W. F. K. Wynne-Jones is primarily interested in electrochemistry, electrode processes, corrosion, and the properties of hydrogen peroxide solutions. In addition, he and Dr. H. A. Blayden are directing the work of the Northern Coke Research Laboratories of the British Coke Research Association, located in the Department. Here fundamental investigations are made on the identification, physical and chemical characterization of gases, cokes, the nature of the carbonization process, etc. Dr. J. Weiss and collaborators are studying the chemical effects of ionizing radiations. (auth)

622

Office of Naval Research, London
PHYSICS RESEARCH AT HEIDELBERG. Gordon F. Hull, Jr. July 27, 1950. 5p. (ONRL-80-50)

The physics research at the University of Heidelberg, Germany, is conducted at both the Physical Institute of the University and the Kaiser Wilhelm Institute. Professor W. Bothe is in charge of both institutes; the major emphasis in research is on cosmic rays and nuclear physics. Some research in optics is also being carried out which consists in measurements of the reflection coefficient of metals for various wavelengths of light. (auth)

623

Office of Naval Research, London
PHYSICS RESEARCH AT THE UNIVERSITY OF GENEVA. Gordon F. Hull, Jr. July 14, 1950. 4p. (ONRL-69-50)

At the Physical Institute of the University of Geneva, Switzerland, Professor R. Extermann is developing a research program in several fields of physics. These fields include x-ray and electron diffraction studies of piezoelectric crystals, the dissociation of organic molecules by thermal neutrons, and microwave phenomena. The microwave research consists in a study of the Faraday effect, measurement of dielectric constants and permeabilities, and nuclear resonance. (auth)

## ASTROPHYSICS

624

ON THE ORIGIN OF THE LIGHTER ELEMENTS. William Band. Phys. Rev. 80, 813-18(1950). Dec. 1.

Maria Mayer and Teller have proposed accounting for the relative abundances of the heavier elements as products of the fission of a cold polyneutron fluid. The present paper proposes to account for the lighter elements as having been formed at an earlier stage in evolution when temperatures were high enough to permit nuclear reactions. The primordial neutron-rich nuclear fluid first separates into two phases: the condensed super-clusters or stars which eventually cool to become the Mayer-Teller polyneutrons, and an atmosphere or vapor of small clusters that become the lighter elements. The quantum statistics of a dissociative clustering nucleon gas is worked out and yields equilibrium abundances of the small clusters or light nuclei in the vapor that agree qualitatively with the observed abundances if the temperature T of the equilibrium is assumed to be such that kT = 5 Mev. (auth)

## COSMIC RADIATION

625

COINCIDENCES OF PULSES IN SEVERAL IONIZATION CHAMBERS. S. I. Nikol'skiĭ. Doklady Akad. Nauk S.S.S.R. 74, 695-8(1950) Oct. 1. (In Russian)

A "density transition effect," which testifies to the simultaneous appearance of several high-energy particles generating "electron-nuclear showers" and, consequently, proves their cascade-like multiplication, has been described by Russian workers (Birger et al., Zhur. Eksptl'. i Teoret. Fiz. 19, 826(1949), NSA abstract 4-2007; Guro et al., Doklady Akad. Nauk S.S.S.R. 67, 623(1949), NSA abstract 4-1457). Observations (at 3860 m altitude) are reported here revealing the same effect in "genetically connected nuclear disintegrations" of relatively low energies, observed as multiple coincidences in ionization chambers (Dobrotin et al., Doklady Akad. Nauk S.S.S.R. 57, 443(1947); Nikolaev et al., ibid. 65, 481(1949), NSA abstract 4-208). Experiments consisted of comparisons between coincidence counts in the presence and in the absence of a graphite filter above the chambers, correlation determinations between pulse intensity and multiplicity order of coincidences (for the elimination of the effect of showers of relativistic particles), and counts in the presence of an Al filter between chambers (for testing for protons accompanied by relativistic particles see Bagge, Ann. Physik 39, 512(1941) .

626

COSMIC RAY INTENSITY MEASUREMENTS AT BANGALORE 3°N(MAG). G. S. Gokhale, A. W. Pereira, and A. S. Rao. Proc. Indian Acad. Sci. 32A, 98-104(1950) Aug.

A number of balloon-flight experiments were conducted at Bangalore, India, 3°N(mag) to measure and study the variation of the different components of cosmic radiation with altitude. Total vertical intensity was obtained with quadruple-coincidence telescopes with double-counter trays up to an altitude of 27.5 km. The vertical intensity of cosmic radiation penetrating 10 cm of Pb was measured by quadruple-coincidence telescopes with single-counter trays and with double-counter trays. The intensity of the penetrating component increases monotonically with altitude in all the flights, but the ratio of the intensity at the 100-mb level to that at ground level differs by as much as 50% from flight to flight, although the ground intensity agrees in all cases to within 3%, and the measurements were made with standard telescopes. (auth)

627

Office of Naval Research, London
COSMIC RAY MEETING AT OXFORD; MARCH 11-12, 1950. Thomas Coor. Mar. 24, 1950. 31p. (ONRL-31-50)

An informal meeting on cosmic radiation was held in Oxford, England, March 11-12, 1950, under the auspices of the Atomic Energy Research Establishment, Harwell. Workers in this field from all the major cosmic ray laboratories in England were present, and informal talks were given and open discussions held on work in progress in the various laboratories. Of particular interest were talks on nuclear emulsion techniques and meson production studies by the Bristol group, on penetrating showers, meson momentum spectrum, astronomical effects, and cloud chamber techniques by the Manchester group, and on nuclear explosions produced underground by the Birkbeck college group. (auth)

628

Office of Naval Research, London
COSMIC RAY RESEARCH AT THE UNIVERSITY OF ROME. Thomas Coor. July 10, 1950. 5p. (ONRL-63-50)

The Physics Department of the University of Rome is the most active center of physics in Italy. The research program is, with the exception of some work on geophysics, concerned almost entirely with cosmic rays. A summary of some of the cosmic ray problems being investigated is given. (auth)

629

DOUBLE STARS DUE TO COSMIC RAYS. T. T. Li. Phil. Mag. 41, 1152-60(1950) Nov.

Cosmic ray stars are distributed at random over a photographic plate when distances exceeding 1 cm are considered. For small distances of the order of 1 mm the number of close pairs exceeds that expected on a random distribution. The effect is not found on plates exposed at sea level and there is some evidence that it is more marked if dense matter surrounds the plates. Several mechanisms are suggested to account for the effect but none is free from objection. (auth)

630

HEAVY PRIMARY NUCLEI IN COSMIC RADIATION. Hoang Tchang-Fong. Ann. phys. 5, 537-95(1950) Sept-Oct. (In French)

Nuclei of $Z > 2$ were observed in emulsions exposed at 22 km altitude. The flux at the limit of the atmosphere is $(1.01 \pm 0.05) \times 10^3$ heavy nuclei/cm$^2$/sec/steradian, and the mean free path in air is 35 g/cm$^2$. In 50 to 65% of cases, Z is less than 10, so that the corresponding nuclei are probably C, N, or O. The processes observed involve energies of $10^4$ Mev and can be interpreted as nuclear evaporations with low excitation energies. Mean free paths of effects observed are 37 and 25 g/cm$^2$ for nuclei with $Z < 10$ and $\geq 10$, respectively. There were two cases of weak disintegration effects due to feeble nuclear excitations produced by the passage of a heavy nucleus without ensuing collision. (auth)

631

HIGH ALTITUDE INTENSITY OF PENETRATING COSMIC RAYS AT POONA 9°N(MAG). K. S. Chandrasekharan, G. S. Gokhale, and A. S. Rao. Proc. Indian Acad. Sci. 32A, 95-7 (1950) Aug.

High-altitude balloon-flight experiments were conducted at Poona, India, 9°N(mag) to measure cosmic-ray intensity with quadruple-coincidence-counter telescopes with 10 cm of Pb between the counters, using the radiosonde technique. Heights of 60,000 ft (100 mb) were reached. It is concluded that the intensity of cosmic radiation penetrating 10 cm of Pb absorber increases monotonically with decreasing atmospheric pressure. (auth)

632

Office of Naval Research, London
THE INSTITUTE OF EXPERIMENTAL PHYSICS OF THE

UNIVERSITY OF GENOA. Thomas Coor. July 10, 1950. 3p. (ONRL-64-50)

A brief description is given of the personnel, facilities, and research program of the Institute of Experimental Physics of the University of Genoa, Italy. This small cosmic ray research program is being coordinated with work in progress at the University of Brussels and the Max Planck Institute, Göttingen. (auth)

633

INVESTIGATION OF THE WIDTH OF COSMIC-PARTICLE SHOWERS AT SEA LEVEL. L. Kh. Eĭdus, N. M. Blinova, V. G. Videnskiĭ, and L. D. Suvorov. Doklady Akad. Nauk S.S.S.R. 74, 477-80(1950) Sept. 21. (In Russian)

Zatsepin et al.(Zhur. Eksptl.' i Teoret. Fiz. 17, 939(1947); Doklady Akad. Nauk S.S.S.R. 61, 47(1948) and 67, 993(1949)) and Skobel'tsyn et al. (Phys. Rev. 71, 315(1947); Doklady Akad. Nauk S.S.S.R. 67, 45(1949)) have shown that measurements of extensive atmospheric showers were in complete disagreement with the cascade theory; at distances of about 1 km between recording instruments, coincidence numbers were dozens of times higher than those calculated; the shower's "trunk," composed of high-energy electrons, was also much wider than expected. These discrepancies were qualitatively explained by Zatsepin by assuming extensive cascades of high-energy nuclear disintegrations. However, in the present authors' opinion, at high altitudes (3860 m), where these investigations took place, all these pictures are too complicated to permit clear interpretations. Accordingly, they undertook similar experiments at sea level, where the filtering and sorting out of components is more advanced. The general result was a confirmation of previous findings on the abnormally wide areas covered by the showers. Moreover, a clearly defined difference is manifest between processes in the vicinity of the shower's center (< 25 m from center) and those taking place in its wide peripheral parts. Whereas in the center cascade multiplication of electrons obeys the classical theory, some other mechanisms are at work in the periphery. These latter are probably not linked with any nuclear cascades; possibly electrons in equilibrium with mesons are involved.

634

OBSERVATIONS OF COSMIC-RAY EVENTS IN NUCLEAR EMULSIONS EXPOSED BELOW GROUND. E. P. George and J. Evans. Proc. Phys. Soc. (London) 63A, 1248-64 (1950) Nov. 1.

Ilford nuclear research plates were manufactured in a laboratory at an equivalent depth of 60 m of water below ground. After having been stored at various depths, the plates were processed below ground. The observed frequencies of $\mu$ mesons stopped in the plates are consistent with those expected from measurements on the energy spectrum of cosmic rays. Several $\pi$ mesons stopping in the plates were observed, and reasons for believing these to have been locally produced in the matter near the plates are discussed. Forty-two nuclear disintegrations have been observed, the frequency at a depth of 60 m water equivalent being of the order of $5 \times 10^{-3}$ stars/cm$^3$/day. Approximately $\frac{1}{3}$ of these are attributed to the electromagnetic interaction of $\mu$ mesons on their passage through nuclei. The remainder are attributed in part to neutrons from this first group of stars, and in part to the photons of the soft component underground. Four examples of stars accompanied by showers of particles at minimum ionization have been observed, and are discussed. (auth)

635

PENETRATING PARTICLES IN AIR SHOWERS. C. B. A. McCusker. Proc. Phys. Soc. (London) 63A, 1240-47(1950) Nov. 1.

The penetrating particles in extensive air showers are compared directly with the penetrating particles in the main cosmic-ray beam. It is found that not more than $70 \pm 3\%$ of the air-shower particles are single $\mu$ mesons, while the remainder are strongly interacting particles. The barometer coefficient of extensive penetrating showers is determined. (auth)

636

PENETRATING SHOWERS IN CARBON. John R. Green. Phys. Rev. 80, 832-41(1950) Dec. 1.

The penetrating showers generated in C by cosmic radiation have been investigated by means of a cloud chamber containing both C and Pb plates which was operated at an elevation of 12,000 ft. It is shown that the penetrating showers generated in C are almost the same in angular distribution and in average multiplicity of penetrating particles as the penetrating showers produced in Pb, comparison values in Pb being obtained from previous work with the same cloud chamber containing only Pb plates. Penetrating showers produced in the C plates were followed not infrequently by production of secondary penetrating showers farther down in the C; the initiating particles of the subsequent showers are very closely aligned with the direction of the primary particles of the parent penetrating shower. The mean free path of the lightly ionizing secondary particles of the penetrating showers for subsequent production of nuclear events was found to be $237 \pm 29$ g/cm$^2$ C. The mean free path of the penetrating particles for large-angle scattering in the C is about four times this value. The electronic cascades produced at the same time as the penetrating component are satisfactorily explained in order of magnitude by assuming that they are produced by high energy $\gamma$ rays which originate at the event or which may be derived from the fast decay of neutral mesons very near the original event. (auth)

637

Evans Signal Laboratory

REPORT OF SIGNAL CORPS OBSERVER ON HIGH ALTITUDE COSMIC RAY MEASUREMENTS IN SOUTH PACIFIC DURING JULY–AUGUST 1949. Ira O. Myers. Dec. 1, 1949. 23p. (NP-1843; Technical Memorandum M-1309)

Under an Office of Naval Research contract, physicists at Princeton University are engaged in an extensive cosmic ray investigation. Part of this work calls for cosmic ray experiments at high altitudes and low latitudes. The U.S.S. Norton Sound was made available during the summer of 1949 by the Navy and was used as a launching base for balloons which carried the various pieces of experimental equipment to high altitudes. The experiments carried out on this project may be separated into three parts: (1) ionization chamber bursts at high altitudes, (2) neutron intensity

measurements at high altitudes, and (3) investigation of east-west asymmetry at high altitudes and low geomagnetic latitudes. The equipment and methods employed in this investigation are described. 8 figures.

638

ROSSI CURVE FOR ABUNDANT SHOWERS. Guy Carmouze and Jean Daudin. Compt. rend. 231, 572-4(1950) Sept. 18. (In French)

The Rossi curve for the abundant nuclear showers observed beneath a thin screen is rendered obscure by the background due to air showers. In order to remove this background, an arrangement of 6 counters grouped in pairs beneath Pb screens and registering triple coincidences (i.e., only showers of at least 4 or 5 trajectories are counted) has been erected in the free air at the Pic du Midi Observatory (2860 m). A bank of counters at 2-m distance determines the events due to air showers. The variation in the coincidences associated and nonassociated with the Auger showers is shown, and a Rossi curve without background is presented. The background caused by air showers is not constant but increases by a factor of 4 between 0 and 24 mm Pb. The showers registered in this experiment have properties in excellent accord with the theory of cascades.

639

Office of Naval Research, London
THE TESTA GRIGIA HIGH ALTITUDE LABORATORY. Thomas Coor. July 17, 1950. 3p. (ONRL-70-50)

A high-altitude cosmic-ray research laboratory has been set up at an altitude of 3500 meters in the Italian Alps by the "Centro di Studio per la Fisica Nucleare" of the Italian National Research Council. This laboratory, The Testa Grigia High Altitude Laboratory, is located on Pian Rosa, near Cervinia (the Matterhorn), and can be reached the year round by means of a cable car from the town of Breuil. The administration and research facilities are described. (auth)

## ELECTRONS

640

University of California Radiation Laboratory
THE X-RAY SPECTRUM PRODUCED BY 322-MEV ELECTRONS STRIKING A PLATINUM TARGET. Walter Hartsough, Milton Hill, and Wilson M. Powell. Aug. 1, 1950. 23p. (UCRL-660)

The differential energy spectrum of the photons produced by 322-Mev electrons striking a 20-mil Pt target was measured by observing the energy of 3467 pairs produced in a 1-mil Pb foil in a Wilson cloud chamber in a magnetic field of 10,000 gauss. The spectrum is found to agree with that predicted by the Bethe-Heitler bremsstrahlung theory (Proc. Roy. Soc. (London) 159, 432(1937)) using a Thomas-Fermi model with suitable corrections for the thickness of the target. The energy of the 322-Mev electrons was determined by the spectrum of the photons observed in this experiment. (auth)

641

THE EFFECT OF NUCLEAR STRUCTURE ON THE ELASTIC SCATTERING OF FAST ELECTRONS. L. R. B. Elton. Proc. Phys. Soc. (London) 63A, 1115-24(1950) Oct. 1.

The cross section for the scattering of electrons by atomic nuclei is investigated at energies for which the nuclei can no longer be treated as point charges. Two simple nuclear models are used. A general expression is obtained using Born's approximation, and an exact numerical calculation is carried through for 20-Mev electrons scattered by gold nuclei. It is concluded that at this energy considerable deviations from the formulae which treat the nucleus as a point charge should be expected, and that these should furnish some information about the charge distribution within the nucleus. (auth)

642

THE EFFECT OF SCREENING ON THE CROSS SECTION FOR PAIR PRODUCTION BY ELECTRONS. D. G. Ravenhall. Proc. Phys. Soc. (London) 63A, 1177(1950). (Letter to editor)

Certain cosmic-ray events in photoemulsions have been interpreted as pair production by high-energy electrons colliding with nuclei (see, e.g., Bradt et al., Helv. Phys. Acta 23, 43(1950)), in accordance with the theory given by Racah in Nuovo cimento 14, 3(1937). An estimate was made by the author of the effect of the screening of the nuclear field by atomic electrons. It was found that, for a 1000-Mev electron and a nucleus with Z = 40, the cross section for the process is decreased by about 6%, while for a 10,000-Mev electron the corresponding value is 18%. Pairs may also be produced in electron-electron collisions; for a 1000 Mev electron, this contributes an additional 3% to the cross section per unit volume for nuclear collisions.

643

EXPERIMENTAL VERIFICATION OF SPACE CHARGE AND TRANSIT TIME REDUCTION OF NOISE IN ELECTRON BEAMS. C. C. Cutler and C. F. Quate. Phys. Rev. 80, 875-8(1950) Dec. 1.

A simple experiment is described which indicates some significant properties of the noise currents in a long electron stream, and verifies the applicability of the theory as worked out by Rack (Bell System Tech. J. 17, 592(1938)), Peterson (Proc. I.R.E. 35, 1264(1947)), and Pierce (Traveling Wave Tubes, N. Y., D. Van Nostrand Company, Inc., 1950) to the noise properties of klystrons and traveling-wave tubes. By moving a small coaxial resonant cavity along a beam from an electron gun, the noise power coupled into the cavity could be measured at different distances from the anode. The noise current went through a sharp minimum at about 1-in. distance, in good agreement with theory.

644

MULTIPLE PROCESSES IN THE PRODUCTION OF PAIRS OF ELECTRONS BY $\gamma$-RADIATION. J. E. Hooper and D. T. King. Phil. Mag. 41, 1194-7(1950) Nov. (Correspondence)

An investigation of the pairs of electrons created in photographic emulsions exposed at an altitude of 68,000 ft, and

resulting from the passage of $\gamma$ radiation arising in the decay of $\pi^0$ particles, is reported. Among 1380 pairs, two examples which appear to correspond to the simultaneous production of two pairs of electrons were found. A mosaic of photomicrographs of one of these events is shown. In both cases the associated tracks are of sufficient length to allow determination of the grain-density in the tracks and the momenta of the particles by the scattering method.

645

NON-PHYSICAL SOLUTIONS IN CLASSICAL FINITE ELECTRON THEORY. J. Irving. Proc. Phys. Soc. (London) 63A, 1125-31(1950) Oct. 1.

An approximate linear form of the Peierls-McManus equations of motion for an electron is shown to yield runaway solutions for a particular influence function, which otherwise satisfies all the conditions imposed by the theory. The general problem is to discuss the existence of complex roots of a transcendental equation for an arbitrary form of the influence function. It is shown that this equation always has roots. These, however, may be such that the corresponding motion of the free electron is of a damped nature. It has not been found possible to construct a function which avoids runaway solutions or to prove whether or not such a function exists when all conditions are satisfied. (auth)

## INSTRUMENTS

646

New York Operations Office, AEC
DETECTION OF PULSES SUPERIMPOSED ON FLUCTUATION NOISE. Bernard M. Dwork. [nd.] Decl. Aug. 23, 1949. 25p. (AECD-2970; NYOO-69)

A single pulse of known shape superimposed on a background of noise having a known spectrum is considered. The characteristics of the optimum linear circuit to be used in connection with an amplitude discriminator (to detect the presence of the pulse) are studied. The optimum results are determined. The problem of physical reliability of the optimum network is solved for the case of a flat noise spectrum. The optimum results are compared with the results obtained using a simple R-C circuit for pulse shapes of practical interest. (auth)

647

Argonne National Laboratory
SOME APPLICATIONS OF PHOTOMULTIPLIER TUBES IN SPECTROGRAPHIC ANALYSIS. James K. Brody. Aug. 1950. Decl. Oct. 12, 1950. 23p. (AECD-2994; ANL-HDY-678)

A flexible mounting for two photomultiplier photocells for use in a direct-reading spectrograph has been constructed. Each photomultiplier tube may be independently engaged to a screw which is turned by a synchronous motor. Provisions are made for disengaging each tube and locking it in position. Each tube mounting is provided with a means of rotation so that the tube may be made to lock at the grating for any rotation of the grating and any position of the plate-holder. The tube may also be moved with respect to the pickup slit so that light falls on the photosensitive cathode. The scanning speed may be changed by changing the gear ratio on the screw drive. Automatic limit switches are provided to reverse the tube as it approaches the limit of its movement. Three types of analytical procedures have been carried out successfully with the photomultiplier tubes: lithium determinations in the flame, uranium isotopic determinations, and scandium in the copper spark. All these methods have one thing in common; the sample spectrum is excited continuously for a period of 30 sec or longer. Any sample that volatilizes and escapes rapidly must be continuously resupplied in the source. The application of photomultipliers has proved quite valuable because of the improved accuracy and economy of time. 10 figures.

648

Carbide and Carbon Chemicals Division, UCC, K-25
AN INSTRUMENT FOR CONTROLLED POTENTIAL ELECTROLYSIS. E. D. Marshall, J. Farquharson, and Lewis H. Rogers. Dec. 1, 1950. 15p. (K-698)

An instrument is described that will automatically regulate the potential of an electrode to within ±10 millivolts of a preselected value. Circuit diagrams are included for this instrument, which is simple to operate and relatively inexpensive. The group II cations, copper, bismuth, lead, and cadmium were readily separated and determined coulometrically with the aid of this instrument. (auth)

649

University of Rochester Atomic Energy Project
THE MODIFIED CASCADE IMPACTOR. Sidney Laskin. Aug. 8, 1950. 31p. (UR-129)

The Modified Cascade Impactor is a multiple-stage aerosol sampling device used for the characterization of atmospheric contaminants in terms of particle size and concentration. Excellent results are obtained in the range 0.2 to 50$\mu$. The design permits interchangeable jets, accurate slits, and the sturdiness and duplication of construction required for practical use. In principle, the instrument employs a series of four jets of decreasing areas and collecting slides arranged in tandem. These are followed by a fifth sampling stage in the form of a filter paper. The special advantage of the Modified Cascade Impactor has been in the development of a procedure whereby particle size-mass distributions can be determined by a chemical or physical analysis of the total particulate mass collected at each stage without resorting to counting the particles or measuring their diameters. The Impactor has been applied in the characterization of dust and mist atmospheres of uranium and beryllium compounds. The instrument may also be used for the size-distribution analysis of a mixture of dusts such as is frequently encountered in many industrial atmospheres. 12 figures.

650

University of Rochester Atomic Energy Project
PRODUCTION DESIGN OF THE MODIFIED CASCADE IMPACTOR. S. Laskin, R. H. Wilson, K. E. Lauterbach, L. J. Leach, and D. W. Falconer. Aug. 8, 1950. 16p. (UR-130)

Machining and assembly diagrams are given for the Modified Cascade Impactor described and illustrated in report UR-129, abstracted as NSA 5-649.

651

ELECTRONIC RADIOGRAPHY BY TRANSMISSION USING RADIOACTIVE MONOLAYERS. D. E. Beischer. Science 112, 535-6(1950) Nov. 3.

A radiographic method using a uniform, plane $\alpha$, $\beta$, or $\gamma$ source, prepared in the form of mono- or multilayers of radioactively labeled molecules by the technique of Langmuir and Blodgett (J. Am. Chem. Soc. 57, 1007(1935)), is described. A $\beta$-emitting source can be prepared by spreading $C^{14}$-labeled stearic acid on the surface of an aqueous solution ($10^{-4}$M $CaCl_2$, $10^{-3}$M $KHCO_3$) and transferring the monomolecular film of calcium stearate to a solid substratum by dipping a mica plate once or several times through the surface. By cleaving the mica sheet, two sources buttered with radioactive material on only one side can be prepared. The picture of a thin specimen in the $\beta$ light of $C^{14}$ can be prepared by enclosing the specimen in a printing frame between the radioactive layer and a photographic emulsion. Although the method is limited in resolving power, and the useful magnification cannot exceed 10, the wide variety of electron velocities which can easily be applied by changing the radiating element in the source offers an inexpensive possibility for studies of transmission of electrons over a considerable range. The establishment of electron radiography on a quantitative basis is discussed.

652

STEREO-TELEVISION IN REMOTE CONTROL. H. R. Johnston, C. A. Hermanson, and H. L. Hull. Elec. Eng. 69, 1058-62(1950) Dec.

An experimental 3-dimensional television system has been developed for the purpose of investigating its use as a viewing system for remote manipulation in atomic energy research. Standard television equipment has been modified by the use of stereoscopic principles to evolve the equipment.

## ISOTOPE SEPARATION

653

Yale University
FIRST REGULAR ANNUAL PROGRESS REPORT FOR JULY 1, 1949 - April 1, 1950. W. W. Watson. Apr. 1, 1950. 19p. (NYO-503)

Progress made in isotope separation by thermal diffusion and in spectroscopic work with separated isotopes during the period is reported. Several 40-cc samples of argon whose $A^{36}$ content is 95.9% have been obtained. Study of the $A^{36}(d,p)A^{37}$ reaction indicates excited states of the $A^{37}$ nucleus to lie at 1.44, 2.56, 3.54, 4.40, 4.63, 5.07, and 5.85 Mev. Aided by the 10-fold enrichment of $A^{38}$ in these samples, the $\beta$ emission of the resulting $A^{39}$ is being investigated. Experiments on concentrating $He^3$ by thermal diffusion have been completed. The highest concentration obtained was 0.45% $He^3$. The experiments stimulated by early and unproved results with thermal diffusion columns that a certain amount of turbulence improves the isotope separation look promising. The spectral isotope-shift studies with $Pb^{204}$-enriched material have been completed, and the isotope shifts for $Pb^{210}$ and gadolinium are to be measured. Improvements in the mass spectrometer are outlined, and the future experimental program is briefly described.

## MASS SPECTROGRAPHY

654

THE APPLICATION OF THE MASS SPECTROMETER TO CHEMISTRY. J. D. Morrison. Roy. Australian Chem. Inst. J. Proc. 17, 339-50(1950) Sept.

A general discussion of the application of the mass spectrometer to analysis and to studies of molecular structure and bond energies is presented.

## MEASURING INSTRUMENTS AND TECHNIQUES

655

University of Chicago Metallurgical Laboratory
BALLISTIC ELECTROMETER METHOD OF MEASUREMENT OF SMALL ION CURRENTS. James W. Broxon and William H. Hinch. Dec. 11, 1943. Decl. Aug. 2, 1950. 14p. (AECD-2985; CP-1155; A-1640)

Small ion currents have been measured by allowing electricity to accumulate on the insulated electrode of an ionization chamber, and then suddenly sharing the charge with the input grid of a 959-tube d-c amplifier with grid leak, thus producing a ballistic throw of a recording meter. The periods of accumulation and the sharing of charge were controlled by relays operated by clockwork. Accumulation periods of 1 to 30 min have been employed. The latter yields full-scale deflection for an ionization current of about $10^{-14}$ amp in a 1200-cc chamber with 19-mmf capacity. This corresponds to a radiation intensity of 1 mr/8hr. It is found that with a chamber of low electrical capacity filled with argon at 10 atm, the sensitivity to $\gamma$ radiation should be quite as high as that of G-M counters. Copies of records obtained with the several accumulation intervals for the decay of artificially radioactive materials are included.

656

Los Alamos Scientific Laboratory
RISE AND DECAY TIMES OF PULSES FROM PHOTOMULTIPLIERS USING LIQUID PHOSPHORS. James S. Allen and Theodore C. Engelder. [nd.] 6p. (AECU-996; LADC-871)

Little of a quantitative nature has been reported about rise and decay times of pulses from photomultipliers utilizing liquid phosphors. These pulse constants have now been measured for the most promising liquid scintillators, i.e., terphenyl in various solvents, using a photographic method to record single pulses from a photomultiplier tube. A weak $Co^{60}$ source was used for excitation. Terphenyl in any of the solvents tested has significantly better pulse characteristics than trans-stilbene. It appears that the decay time decreases with increasing concentration. Correction factors are discussed.

657

Los Alamos Scientific Laboratory
CORRECTION FORMULAS FOR THE $Li^6$ METHOD. A. J. F. Seigert and George R. Keepin, Jr. June 6, 1950. 16p. (LAMS-937)

The finite thickness of emulsion requires that certain track selection criteria be observed in making measurements on $Li^6$-loaded emulsions. These criteria depend, among other things, upon incident neutron energy, the direction and degree of collimation of the incident neutrons and upon the orientation of the track with respect to the emulsion. As a result of such selection, suitable corrections must be applied to the observed distribution. This paper develops the analytic expressions for three situations. Families of curves for each situation are also presented. (auth)

658

Los Alamos Scientific Laboratory
LOSSES AND ERRORS IN COUNTING DUE TO THE ELECTRONIC EQUIPMENT. James D. Gallagher. May 3, 1950. 16p. (LAMS-1108)

Losses due to recovery time, deviation from true average counting rate, and errors in coincidence counting are discussed. The information may be of value when designing equipment for a specific use or when determining the practicability of using an existing instrument in a particular experiment. The losses as discussed apply to random counting but not to counting radiation from a chain-reacting system.

659

General Electric Co.
FINAL REPORT; ALPHA GAMMA PROPORTIONAL COUNTER FEASIBILITY STUDY. Apr. 28, 1950. 48p. (NYO-1514)

In general, proportional counters can be used for both alpha and beta-gamma counting. Depending on the conditions, a single unit can be used for alpha and beta-gamma counting simultaneously, or two units can be used, using one for alpha and one for beta-gamma counting. These systems and their limiting conditions are discussed. As an important corollary to this work, an attempt is made to define the design and operating limitations on proportional counters. (auth)

660

Oak Ridge National Laboratory
INSTRUMENT RESEARCH AND DEVELOPMENT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JULY 15, 1950. W. E. Thompson, Comp. Oct. 20, 1950. 65p. (ORNL-796)

Alpha-energy Analyzer. E. Fairstein. The faults found during more than a year's operation are summarized. Both the main amplifier and preamplifier have been redesigned. The new circuit is described and diagramed.

Constant-Q Pulser. R. A. Dandl. A diagram of a pulse generator built to test high-gain, wide-band amplifiers, and differential discriminators is shown.

Moving-film Pulse Analysis. R. S. Stone and C. J. Borkowski. By feeding pulses into an oscilloscope and photographing the scope screen with a moving-film camera, the speed and accuracy of the multichannel analyzer and the resolution of the single-channel analyzer are obtained. Two variations of the method are described, and sample film records are shown.

Portable Alpha Survey Meter. W. M. Hurst. Modifications in the probe have been made which allow operation of the instrument in 98% relative humidity without a desiccant.

Continuous Water Monitoring. W. M. Hurst. The instrumentation problems of monitoring a municipal water supply are discussed, and the design components of a continuous water monitor are presented.

Instrument Department. Brief reports are presented under the following headings: Cockcroft-Walton generator, magnetic analyzer, accelerator-tube studies, resonance analyzer, line-noise monitor, neutron chambers, neutron time-of-flight spectrometer, liquid-level telemeter, regulated power supplies for magnets, electromagnetic flow meter, multichannel remote indicating comparator, high-speed motion picture studies, changes in design and fabrication of electronic chassis, demonstration pile simulator, revised A1 amplifier and A1B preamplifier, recording manometer for physiological pressures, redesign of 64-scaler, modification of hand and foot counters, Lauritsen electroscope, ten-cell counting-planchet electroplating apparatus, and instrument construction and maintenance.

Scintillation Spectrometry. P. R. Bell, J. M. Cassidy, R. C. Davis, W. H. Jordan. The energy resolution and accuracy of energy measurement have been considerably improved for both $\beta$ and $\gamma$ rays. The properties of anthracene, NaI(Tl), and solution phosphors are discussed extensively, and pulse-height curves for various types of radiation are shown. The $\gamma$ rays of $K^{40}$ were redetermined with the NaI crystal. An attempt was made to find $\gamma$-ray activities among the rare earths. The measurement of fast-positron annihilation with the scintillation spectrometer was investigated, and the temperature dependence of scintillation pulses in anthracene was measured. 18 graphs.

Proportional Counters. J. E. Francis and J. I. Hopkins. A curve obtained with experimental proportional counters for the 8.6-kev x ray of $Zn^{65}$ is shown.

Multichannel Analyzer. G. G. Kelley. Circuits have been included to make the amplifier inoperative during the time a pulse is being measured. A schematic diagram of the pulse sorter chassis is given.

661

Oak Ridge National Laboratory
TROUBLESOME EFFECTS OF LINE NOISE ON PARTICLE COUNTING. C. G. Goss and F. M. Glass. Nov. 14, 1950. 12p. (ORNL-853)

A recent study of line disturbances reveals that the accuracy of low-level counting is often impaired by oscillatory power-line transients. Some of the sources of these disturbances, their characteristics, and a simple instrument for monitoring a noisy line are discussed. The monitor is illustrated and diagramed.

662

University of California Radiation Laboratory
PROCESSING AND EXPOSURE OF ELECTRON SENSITIVE

EMULSION TO HIGH ENERGY ELECTRONS AND POSITRONS. (abstract). Charles E. Violet, F. C. Gilbert, and Walter H. Barkas. Oct. 31, 1950. 1p. (UCRL-977)

The report is reproduced here in its entirety.

In order to use sensitive emulsions for the study of electron interactions, it is necessary to erase the old tracks which interfere with the analysis. A method suggested by J. Spence (Kodak Research Laboratory, Eastman Kodak Company) for this purpose has been adopted. The plates are kept at a temperature of 95° F in saturated water vapor for 60 hr just prior to use. This treatment eradicates virtually all the old electron tracks. After exposure the plates are developed using a modification of a procedure devised by Occhialini. With this development high-energy electron tracks have a grain density of 40 grains/100 $\mu$ in G-5 emulsion. Tracks to be used in measuring mean free paths in emulsion for various electron and positron processes were produced by exposing G-5 plates in a magnetic pair spectrometer situated in the x-ray beam of the synchrotron. Separated electrons and positrons of 200, 100, 70, 40, and 20 Mev were recorded.

663

University of California Radiation Laboratory
GRAIN DENSITY MEASUREMENTS IN NUCLEAR EMULSIONS. (abstract) J. Kent Bowker, John R. Green, and Walter H. Barkas. Oct. 31, 1950. 1p. (UCRL-979)

The report is reproduced here in its entirety.

The validity of the relation $dN/dR = f(dE/dR)$ has been studied for high-energy charged particles. N is the number of grains in a residual range R, and E is the kinetic energy of the moving particle. From grain counts of mesons, protons, and alpha particles it is found that the grain density does not depend explicitly on the charge of the moving particle, but to good approximation just on its rate of energy loss. It is found also that when dN/dR is small, it becomes proportional to dE/dR. A saturation effect exists because only a finite density of potentially developable grains are threaded by the moving particle, so dN/dR cannot rise in proportion to dE/dR as the particle slows down. By measuring the gap density, g(R), in clogged tracks, one may determine the probability of grains not being rendered developable. A relation $G/M = F(R/M)$ holds for particles of the same charge, where $G(R) = \int_0^R g(R)dR$. Measurements on the "integrated emptiness" of tracks demonstrate that in the region where grain counting fails because of clogging, gap measurements provide reliable mass ratios.

664

University of California Radiation Laboratory
STARS IN PHOTOGRAPHIC EMULSIONS INITIATED BY PROTONS. (abstract) Lawrence S. Germain. Oct. 31, 1950. 1p. (UCRL-981)

The report is reproduced here in its entirety.

A study has been made of stars in photographic emulsions initiated by protons from the 184-in. Berkeley cyclotron. Ilford G-5 electron-sensitive plates were exposed to the proton beam with the emulsion parallel to the beam. A workable exposure, about 20 proton tracks per 100-$\mu$ field of view, was obtained by dropping the plates through the deflected proton beam of the cyclotron. Energies as low as 95 Mev were obtained by placing Al absorbers in front of the plates. The plates were scanned for all stars initiated by the protons, and the total length of proton track was found by examining sample areas. The average number of prongs per star and the cross section for production of stars of two or more prongs was calculated for various energies between 95 and 340 Mev. Both of these quantities increased with increasing energy up to the highest energy used. At 340 Mev the cross section was found to be 0.29 barn while the average number of prongs per star was 3.9.

665

COMPARISON OF GEIGER-COUNTER AND ION-CHAMBER METHODS OF MEASURING GAMMA RADIATION. W. K. Sinclair. Nucleonics 7, No. 6, 21-6(1950) Dec.

The basic differences between these two systems of gamma measurements are stated. Response of each to different quantum energies was compared. Results enable counting rates in copper G-M counters to be expressed as dosage rates or vice versa. (auth)

666

COMPUTATION OF THE POTENTIAL PULSE AND OF THE DEAD TIME IN GEIGER COUNTERS. I. A. Kryukov. Zhur. Eksptl'. i Teoret. Fiz. 20, 842-53(1950) Sept. 1. (In Russian)

Formulas for the potential pulse and the dead time in a Geiger counter are derived and compared with the experiment. Depending on working conditions, the time during which electrons are collected on the filament varies between $5 \times 10^{-7}$ and $2 \times 10^{-6}$ sec. Actually observed counter properties can be explained by assuming that the mobility of positive ions is a constant and by taking into account the time required for the collection of electrons. (auth)

667

Office of Naval Research, London
CONFERENCE ON FUNDAMENTAL MECHANISMS OF PHOTOGRAPHIC SENSITIVITY; PART III. NUCLEAR TRACK EMULSIONS; UNIVERSITY OF BRISTOL, MARCH 28-31, 1950. Kenneth R. Eldredge. July 12, 1950. 12p. (ONRL-66-50)

The general trend of the papers concerning nuclear-track emulsions indicates that this method of particle detection can be considered nearly to have reached the limit of its possible precision. Measurements of track lengths, scatter, and other observable phenomena indicate that not a great deal more can be done to improve accuracy. The problems of fading were discussed to some extent, and it was shown that fading may be useful in some cases for improvement of discrimination, or it may be harmful in other cases where long exposures must be made. The general problem of processing nuclear-track emulsions was discussed by two authors, and it is here that greatest improvements still remain to be made. Particularly in the case of the thick emulsions, processing times are very long, 24 hr or more, and until this phase of the problem can be simplified, the use of thick emulsions will be difficult for many laboratories. (auth)

668

THE EFFICIENCY OF THE GEIGER-MÜLLER COUNTER FOR HIGH ENERGY $\gamma$ RAYS, II. Masateru Sonoda. J. Phys. Soc. Japan 5, 403-08(1950) Nov.-Dec.

A calculation of the efficiency of G-M counters for high-energy $\gamma$ rays which takes into account effects of multiple scattering and radiation loss of secondary electrons is presented. A general method and the probability of penetration are considered. Results are indicated by tabular data and curves.

669

Department of Mines and Technical Surveys, Mines Branch, Ottawa
EQUILIBRIUM CORRECTIONS IN GEIGER ANALYSIS. C. Lapointe. Mar. 16, 1950. 9p. (NP-1600)

Determination of uranium in ores and concentrates may be made by a comparison of either the $\beta$ or the $\gamma$ radiation emitted by the sample with that emitted by a standard of known uranium content. The $\beta$ method is best suited for low-grade material, and the $\gamma$ method is used mostly for high-grade ores or concentrates. Since milling processes may disturb the secular equilibrium of the ores by removal of radon or radium, a method has been devised for determining the state of equilibrium. This consists in measuring the ratio of the $\beta$ activity to the hard $\gamma$ radiation of the radium family. Although the method of equilibrium does not possess the high degree of accuracy that could be expected from a chemical analysis, and may sometimes lead to errors because of faulty interpretation of the results, it seems that it is completely suitable for routine determinations, where the measurements need not be more accurate than the sampling. The presence of the thorium radioactive family introduces errors in the physical measurements, and before the equilibrium method is used, one has to know the amount of thorium present in the sample.

670

Office of Naval Research, London
HIGH GAIN PHOTOMULTIPLIERS IN SWITZERLAND. Gordon F. Hull, Jr. July 14, 1950. 2p. (ONRL-68-50)

High-gain photomultiplier tubes which have an amplification of $10^{10}$ are briefly described. When two photomultiplier tubes are used for coincidence counting, the resolution time has been found to be $2 \times 10^{-9}$ sec.

671

A HIGH RESOLUTION BETA-RAY SPECTROMETER. Joseph A. Bruner and F. R. Scott. Rev. Sci. Instruments 21, 545-7(1950) June.

A relatively inexpensive 180-deg magnetic focusing beta-ray spectrometer has been constructed, having a principal orbit radius of 15 cm. A radially inhomogeneous field provides essentially perfect focusing of electrons leaving the source within a 33-deg angle. In operation, with a 1-mm wide source, the transmission is 0.2%, the full width at half-maximum of an internal conversion line is 0.4%, and the effects of background and scattering are generally inappreciable. (auth)

672

A METHOD OF MEASURING SPURIOUS COUNTS IN GEIGER-MÜLLER COUNTERS. D. Willard and C. G. Montgomery. Rev. Sci. Instruments 21, 520-21(1950) June.

A counter was excited by a series of x-ray pulses of short duration occurring at regular intervals. Spurious counts were then easily recognized since they occur between the x-ray pulses. The counter pulses were displayed on an oscilloscope screen with a synchronized sweep and the counter deadtime, recovery time, and number of spurious counts were determined by inspection. More quantitative information of the time distribution was obtained with an electronic circuit that recorded counts in a small arbitrarily chosen interval. It was found that the interval distribution shows at least two maxima. A mechanism is suggested for the appearance of the second maximum in terms of negative ions formed at the cathode by positive-ion bombardment. (auth)

673

PHOTOSENSITIVE GEIGER COUNTERS: THEIR APPLICATIONS. C. E. Mandeville and M. V. Scherb. Nucleonics 7, No. 5, 34-8(1950) Nov.

Historical aspects and principles of operation of photon counters are discussed, and their role in research is reviewed. Development of the scintillation Geiger counter is outlined, and several forms of the device are illustrated.

674

Atomic Energy Research Establishment
THE PRACTICAL CHARACTERISTICS OF THE ALPHA-ELECTROSCOPE NO. 1096. C. J. Mandleberg. Sept. 1950. 15p. (AERE-C/R-582)

The way in which the discharge time of the $\alpha$ electroscope No. 1096 depends on the strength of the source used to discharge it, and the effect on the discharge time of temperature and pressure, the thickness of the tray, and size and other physical characteristics of the source, are demonstrated and discussed. Recommendations for the most effective use of the instrument are made, and it is pointed out that it is hoped to construct an improved $\alpha$ electroscope whose design will be based on the data presented in this report. (auth)

675

PROPORTIONAL COUNTERS—II. Serge A. Korff. Nucleonics 7, No. 5, 46-52(1950) Nov. (see also NSA 4-4035)

Building on the theory presented in the first article (Nucleonics 6, No. 6, 5-10, 36(1950)) of this series, the author presents applicable design considerations. Special attention is given to neutron counters, to the use of radiators, and to methods for eliminating background effects. Counter size, corona discharge, windows for counters, neutron counting, recoil counters, radiators, and construction of counters are discussed.

676

RADIATION MONITORING. SYMPOSIUM ON NUCLEONIC INSTRUMENTATION. Electrician 145, 1240-2(1950) Dec. 1.

A short account is given of a symposium on radiation detecting and measuring apparatus, held in London by the British Institute of Electrical Engineers in November, 1950.

677

THE SCINTILLATION COUNTER. W. Hanle. Umschau 50, 542-3(1950) Sept. 1. (In German)

The detection of ionizing radiation by the scintillation method is briefly discussed, and a general description of the scintillation counter is given.

678

SCINTILLATION EFFICIENCY OF ANTHRACENE CRYSTALS. J. B. Birks. Proc. Phys. Soc. (London) 63A, 1294-5(1950) Nov. 1. (Letter to Editor)

Scintillations produced in anthracene crystals by Po $\alpha$ particles were studied by plotting the scintillation size V (in volts) against the distance x separating the source from the crystal. The curve showed a linear dependence of V on the particle energy E. Observations were also made of scintillations excited by electrons from $In^{114}$. The response of the crystal to different ionizing radiations was measured by plotting $n = dV/dx$ against $m = -dE/dx$, (x in cm air equivalent). At low values of m (electrons >125 kev), n increases linearly, but for high m ($\alpha$ particles of 1.6 to 5.3 Mev) a constant saturation value of n is attained. By interpolation, the value of n for 5 Mev protons can be predicted to be about 50% of that corresponding to an electron of equal energy. Most of the energy of the $\alpha$ particle is dissipated within the crystal in nonfluorescent processes such as chemical dissociation.

679

Evans Signal Laboratory
THE TECHNIQUE AND PHYSICS OF SCINTILLATION COUNTING. H. Kallmann. May 15, 1950. 70p. (NP-1782, Engineering Report E-1044)

Several experiments are described and certain results which have been obtained from them are given. The experiments may be classified roughly as of two types: (1) those concerned principally with basic investigations of scintillation phenomena and (2) those which illustrate various techniques in the application of the scintillation method to the study of nuclear radiations. Certain theoretical considerations dealing with the light emission process are also included. The experiments and discussions placed in group (1) are given under the following headings: alpha particle and fast-electron excitation; a comparison of light output of a crystal in the solid and powdered states; the effect of impurities on the fluorescence; and a study of time dependence of the emission. Those in group (2) are establishing the limits of counting efficiency, the technique of obtaining high counting rates, and coincidence counting techniques with an application to the reduction of the effect of noise. The experiments and discussions under group (1) are concerned mainly with factors which influence the light efficiency of luminescent materials. The emission efficiency is found to be strongly dependent on the density of excitation (interior ionization by incident radiation), on the state of the material (large crystals generally emit less light than the powdered material), and on the extent to which activator atoms are present. Under group (2) the limits of the counting efficiency of a typical arrangement are given in terms of the parameters involved and energy proportional counting is shown to be obtained for efficiencies less than one. (auth)

680

THE VELOCITY OF PROPAGATION OF THE DISCHARGE IN GEIGER-MÜLLER COUNTERS. H. Saltzmann and C. G. Montgomery. Rev. Sci. Instruments 21, 548-9(1950) June.

The velocity of propagation of the discharge in a G-M counter has been measured in a counter with a divided cathode by the method of delayed coincidences. The parameters varied were the counter potential and the percentage of ethyl alcohol mixed with argon. The results are compared with Wilkinson's theory (Phys. Rev. 74, 1417(1948)). Good agreement is obtained except for high velocities where the theory predicts values much too low. (auth)

MESONS

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University of California Radiation Laboratory
PRODUCTION OF $\pi$-MESONS IN NUCLEON-NUCLEON COLLISIONS. Keith Allan Brueckner. July 20, 1950. 33p. (UCRL-715 rev.)

The production of $\pi$ mesons in nucleon-nucleon collisions as predicted by scalar meson theory, pseudoscalar meson theory with pseudoscalar and pseudovector coupling, and vector theory with vector coupling is compared with experimental data from the Berkeley cyclotron. The calculations are made on the basis of third-order perturbation theory using the methods of Feynman and Dyson and also using a phenomenological treatment of the nucleon-nucleon interaction. Account is taken of the fact that the final nucleons are not in plane wave states. It is shown that pseudoscalar theory with pseudovector coupling gives qualitative agreement with experiment. (auth)

682

University of California Radiation Laboratory
THE GAMMA-RAY SPECTRUM FROM THE ABSORPTION OF $\pi^-$-MESONS IN DEUTERIUM. Lee Aamodt, James Hadley, and Wolfgang Panofsky. Aug. 15, 1950. 8p. (UCRL-871)

The $\gamma$-ray spectrum resulting from the absorption of $\pi^-$ mesons in deuterium has been analyzed with a pair spectrometer. The experimental arrangement was similar to that discussed by Panofsky, Aamodt, and York (UCRL-673; Phys. Rev. 78, 825(1950); NSA 4-3976, 6385). The deuterium was contained in a pressure vessel at 2700 psi at the temperature of liquid nitrogen. The observed $\gamma$ rays are attributed to $\pi^- + d \rightarrow 2n + \gamma$, the remainder of the $\pi^-$ captures probably being accounted for by the $\pi^- + d \rightarrow 2n$ reaction.

683

University of California Radiation Laboratory
RELATIVE ENERGY DISTRIBUTION OF LOW ENERGY $\pi^-$-MESONS FROM 390-MEV ALPHA-PARTICLES ON CARBON; STAR FORMATION BY $\mu^-$-MESONS. Stanley B. Jones and R. Stephen White. Aug. 30, 1950. 20p. (UCRL-876)

A part of the energy spectrum of $\pi^-$ mesons generated with the Berkeley 184-in. cyclotron by the bombardment of 0.1 g/cm$^2$ of carbon with 390-Mev $\alpha$ particles has been investigated. The $\pi^-$ mesons were registered in nuclear emulsions. Relative values for the numbers of $\pi^-$ mesons with energies up to 14 Mev were determined at angles up to 60 deg with the beam direction. The maximum of the energy distribution function apparently occurs at an energy greater than 12 Mev. Some information about the star prong spectrum for $\mu^-$ mesons is obtained from a region of the emulsion forbidden, except for scattering, to $\pi^-$ mesons. (auth)

684

University of California Radiation Laboratory
THE CAPTURE OF $\pi$ MESONS IN DEUTERIUM. K. Brueckner, R. Serber, and K. Watson. Sept. 18, 1950. 14p. (UCRL-913)

Panofsky, Aamodt, and Hadley (UCRL-814(Rev.)) find that the capture of $\pi$ mesons in deuterium leads to two-neutron emission in 70% of the cases, and to two neutrons and a $\gamma$ ray in the other 30%. The former process is forbidden for capture of scalar mesons from the K shell. A detailed balancing argument, based on the observed cross section for $2p \rightarrow D + \pi^+$, permits calculation of the nonradiative capture rate from orbits of higher angular momentum. It is shown that this is too small to account for the observation, and the possibility that the meson is a scalar is thus ruled out. This conclusion could be avoided only by postulating the existence of an interaction between meson and nucleons sufficiently large to radically alter the magnitude of the p wave functions near the nucleons. For pseudoscalar mesons, nonradiative capture from the K shell is permitted, and the ratio of radiative to nonradiative transitions can be related to the ratio of meson photoproduction cross section to the cross section for $2p \rightarrow D + \pi^+$. The result is compatible with the type of meson-nucleon coupling which might be expected for pseudoscalar mesons, but uncertainties in the measured quantities are too large to permit a sharper conclusion. (auth) (see also NSA 4-6385)

685

University of California Radiation Laboratory
PHOTO PRODUCTION OF NEUTRAL MESONS FROM HYDROGEN. (abstract) J. S. Steller and W. K. H. Panofsky. Nov. 8, 1950. 1p. (UCRL-1001)

The report is reproduced here in its entirety.

The work of Steinberger et al. (Phys. Rev. 78, 802(1950)) on the production of neutral mesons by photons from the Berkeley synchrotron has been extended using liquid hydrogen as target. Liquid scintillators (0.5% terphenyl in xylene) in sealed glass containers arranged as described in the above reference were used to detect the decay $\gamma$ rays. This experimental setup permits measurement of both meson production angle and correlation angle between the decay $\gamma$ rays. The correlation angle is a calculable function of the $\pi^0$ energy; therefore, the measured distribution limits the choice of $\pi^0$ energy distribution to a considerable extent. Here the recoil nucleus is known to be a proton so that one can calculate the incident photon energy and hence deduce the energy dependence of the production cross section. This is definitely a more rapidly rising function than the excitation function of photo production of charged mesons (Steinberger and Bishop, Phys. Rev. 78, 493(1950)). A value for the total cross section of $1 \times 10^{-28}$ cm$^2$ per effective quantum is observed, in good agreement with the previously reported value from carbon-paraffin difference. Photoproduction cross sections for charged and neutral mesons in hydrogen for 320-Mev bremsstrahlung are thus essentially equal. Work is continuing on the angular distribution of the $\pi^0$ mesons.

## MICROWAVES

686

IMPROVED MICROWAVE SPECTROSCOPE. Electronics 23, No. 12, 126, 214, 216(1950) Dec. (The Electron Art)

Microwave spectroscopy is based on sharp-line resonant absorptions that various gases exhibit throughout the microwave region. This system, while useful in some applications, leaves much to be desired in terms of sensitivity. The Stark modulation system provides increased sensitivity in the detection and measurement of absorptions. The Stark system makes use of the fact that these absorption lines split up or change frequency when a d-c electric field is applied to the absorbing gas. Changes in output power (absorptions) as low as 1 part in $10^9$/cm of absorption path are possible. A block diagram of components and curves for noise figure versus generator impedance in ohms are discussed.

## NEUTRONS

687

University of California Radiation Laboratory
ANGULAR DISTRIBUTION OF NEUTRONS FROM 20-MEV DEUTERONS. (abstract) L. Schecter. Oct. 31, 1950. 1p. (UCRL-976)

The report is reproduced here in its entirety.

The spatial distribution of neutrons produced by the impact of deuterons of maximum energy 20 Mev on various thick targets has been investigated, using the 60-in. cyclotron at the Crocker Laboratory. The neutrons in the energy regions above 20, 11, and 5 Mev were detected by the resulting $\rho$ activities induced in C, Cu, and Be, Al, Cu, Sn, Pb, and U. The distributions vary in a nonregular way from element to element, the characteristic features being the width at half-maximum, and the angular position of the maximum. Among the elements investigated, Be and Cu yield neutrons, which, above 20 Mev, have their spatial maximum displaced from the direction of the incident deuteron beam. At lower energies, this apparent "double peak" is washed out, indicating that the distributions result from the superpositions of several different nuclear processes of comparable importance. This is to be compared to the distributions resulting from

190-Mev deuteron impacts, which agree quantitatively with the single process of stripping.

688

THE TOTAL SCATTERING CROSS SECTION OF NEUTRONS BY HYDROGEN AND CARBON. E. E. Lampi, G. D. Freier, and J. H. Williams. Phys. Rev. 80, 853-6(1950) Dec. 1.

The total cross sections of H and C for neutrons have been determined by measuring the transmission of polythene and graphite scatterers for neutrons with energies 0.798, 1.078, 1.340, 1.578, 4.92, and 4.97 Mev. The correction for the finite geometry of the experiment was made by measuring the cross section as a function of the scatterer area and extrapolating to zero area. The H values for the lowest and highest energies were 2.82 ± 0.07 and 1.34 ± 0.03 barns, respectively, and the C values were 4.79 ± 0.11 and 1.56 ± 0.04 barns, respectively.

## NUCLEAR PHYSICS

689

Office of Naval Research, London
PROBLEM OF NUCLEAR PHYSICS; INFORMAL REPORT ON CONFERENCE AT UNIVERSITY OF BIRMINGHAM, SEPTEMBER 14 to 18, 1948. M. E. Bell. Apr. 22, 1949. 59p. (NP-989)

Papers on experimental and theoretical nuclear forces, field theory, nuclear-energy levels, nuclear isomerism, $\beta$-ray theory, origin of cosmic rays, particle accelerators, particle and radiation detectors, $\beta$-ray spectroscopy, mass spectroscopy, and measurement of short time intervals, presented and discussed by recognized authorities in these fields, are reported.

## NUCLEAR PROPERTIES

690

University of Wisconsin
NUCLEAR ENERGY LEVELS IN LEAD ISOTOPES. R. E. Peterson, R. K. Adair, and H. H. Barschall. [nd.] 9p. (AECU-920)

The total neutron cross section of radiogenic lead was studied as a function of neutron energy in the range 15 to 750 kev, using energy resolutions of 3 to 10 kev. Several resonances were observed; these were interpreted as caused by energy levels in the compound nucleus $Pb^{207}$. The level spacing found in $Pb^{207}$ was of the order of 50 kev. Maxima previously found in the cross section of ordinary lead and attributed to resonance interactions of neutrons with $Pb^{208}$ were re-investigated with better energy resolution. No resonances were observed when earlier measurements of the cross section of Bi were extended to higher energies. (auth)

691

Wesleyan University
PACKING FRACTIONS OF $Fe^{56}$, $Ni^{58}$, AND $Ni^{60}$. Henry E. Duckworth and Howard A. Johnson. [nd.] 1p. (AECU-978)

The report is reproduced here in its entirety.

A large Dempster-type double-focusing mass spectrograph has been used to photograph the doublets $Si^{28}$-$Fe^{56}/2$, $Si^{29}$-$Ni^{58}/2$, and $Si^{30}$-$Ni^{60}/2$. The ions were obtained from a high-frequency discharge between a silicon electrode and one of stainless steel containing about 10% nickel. Exposure times of 30 to 40 sec were adequate for the first doublet while exposures of 3 to 5 min were needed for the other two. The separations $Si^{28}$-$Si^{29}$ and $Si^{29}$-$Si^{30}$, assumed to be integral, provided suitable mass scales. The following packing-fraction differences were found: $Si^{28}$-$Fe^{56}$, $\Delta f = (3.32 \pm 0.02) \times 10^{-4}$ from five photographs; $Si^{29}$-$Ni^{58}$, $\Delta f = (3.07 \pm 0.03) \times 10^{-4}$ from five photographs; $Si^{30}$-$Ni^{60}$, $\Delta f = (2.90 \pm 0.01) \times 10^{-4}$ from eight photographs. The probable errors are based on the internal consistency of the data. No experiments were done to determine the effect of pressure on the doublet spacing (Dempster and Shaw, Bull. Am. Phys. Soc. 24, No. 7, 12 (1949)), but all exposures were taken with the pressure less than $5 \times 10^{-6}$ mm in the analyzing region. Assuming the packing fractions $Si^{28} = -(4.8 \pm 0.07) \times 10^{-4}$, $Si^{29} = -(4.6 \pm 0.07) \times 10^{-4}$, and $Si^{30} = -(5.6 \pm 0.10) \times 10^{-4}$, as given by Bethe and Christy (Isotopic Masses and Abundances, MDDC-887) one can calculate $Fe^{56} = -(8.1 \pm 0.08) \times 10^{-4}$, $Ni^{58} = -(7.9 \pm 0.08) \times 10^{-4}$, and $Ni^{60} = -(8.7 \pm 0.10) \times 10^{-4}$. Typical doublets will be shown and the agreement between these values and other recently reported ones will be discussed.

692

University of Wisconsin
ON THE TRITIUM HFS AND THE ANOMALOUS MAGNETIC MOMENT OF THE TRITON. Edward N. Adams II. [nd.] 21p. (AECU-981)

The hyperfine structure (hfs) of tritium is studied using the model of Aage Bohr according to which the electron centers on the proton at small electron-nuclear separations. The hfs effects due to this recentering of the electron are calculated for three theories of the origin of the triton moment anomaly: the spin-orbital moment theory of Avery and Sachs, the phenomenological interaction moment theory of Blanchard, Avery, and Sachs, and the meson-exchange-moment theory of Villars. In addition the hfs contributions due to relativistic effects of internal nuclear motion are calculated for deuterium, and the result is used to estimate the uncertainty in the tritium hfs coming from this source. It is found that in each case considered the hfs effects may be classified as either "Bohr effect," proportional to the size of the nucleus, or "orbital effect," proportional to the size of the region of centering of the electron. On each of the three theories the total hfs effect is of the order of magnitude of the present experimental uncertainty in the determination of the hfs. While the effect is large enough so that it could be observed with only a small improvement of the experimental precision, it is about the same for each theory considered and would not, therefore, serve as a possible means of distinguishing between the several theoretical accounts of the triton moment anomaly. (auth)

693

University of Wisconsin
ENERGY LEVELS OF $B^{10}$. Fay Ajzenberg. [nd.] 2p. (AECU-1037)

The report is reproduced here in its entirety.

A 50-kv foil of Be was bombarded by 3.436-Mev deuterons. The neutron spectrum was observed by means of nuclear emulsions placed at 10 cm from the target, and at angles of 0 and 80 deg to the beam. Almost 3000 tracks have been measured. Strong evidence is found for levels of $B^{10}$ at 0.73, 3.61, 4.78, 5.13, 5.91, and 6.11 Mev, assuming Q = 4.35 Mev for the $Be^9(d,n)B^{10}$ reaction. It is probable that levels also exist at 5.57, 5.68, 6.33, 6.57, and 6.80 Mev. The intensity and width of the neutron group corresponding to a level at 5.13 Mev indicate possible multiplicity. Similar evidence points to a doublet at 6.11 Mev. The 0-deg data, statistically poor for high-neutron energies, indicates multiplicity in the region of the previously reported level at 2.18 Mev (Rasmussen, Hornyak, and Lauritsen, Phys. Rev. 76, 581(1949)). This is confirmed by the 80-deg data which shows two distinct neutron groups corresponding to $E_x$ = 1.82 and 2.24 Mev. No neutron groups corresponding to levels at 1.46 and 2.89 Mev were found. This result is in disagreement with the equally spaced levels, harmonic-oscillator picture of $B^{10}$.

694

Wesleyan University
MASSES OF $Si^{30}$, $Co^{59}$, $Ni^{60}$, $Zr^{90}$, $Mo^{96}$, AND $Mo^{100}$. Henry E. Duckworth, Richard S. Preston, and Karl S. Woodcock. Mar. 25, 1950. 3p. (NYO-676)

Mass spectrographic determinations of packing-fraction differences in doublets of $Ch_3$-$Si^{30}$, $Si^{30}$-$Ni^{60}$, $Si^{30}$-$Zr^{90}$, $C_2$-$Mo^{96}$, and $C_2H$-$Mo^{100}$, and deduction of the mass of $Co^{59}$ from that of $Ni^{60}$, using disintegration data, lead to mass values as follows:

| | |
|---|---|
| $Si^{30}$ | 29.98290 ± 0.00015 |
| $Co^{59}$ | 58.95029 |
| $Ni^{60}$ | 59.94840 ± 0.00030 |
| $Zr^{90}$ | 89.93178 ± 0.00063 |
| $Mo^{96}$ | 95.93597 ± 0.00039 |
| $Mo^{100}$ | 99.93860 ± 0.00040 |

695

NUCLEAR ENERGY LEVELS FOR SOME LONG-LIVED ISOTOPES. J. M. Cork. Nucleonics 7, No. 5, 24-33(1950) Nov.

The results obtained by photographic spectrometers for a number of long-lived, heavy nuclei that are particularly prolific in gamma-ray yield are reported. The proposed level schemes are presented graphically and include the most recent values for the energies of the beta and the gamma radiation. Results for $Se^{75}$, $Ag^{110}$, $Cd^{115}$, $I^{131}$, $La^{140}$, $Pr^{141}$, $Eu^{151}$ and $Eu^{153}$, $Tb^{160}$, $Yb^{175}$, $Hf^{181}$, $Ta^{182}$, and $Pa^{233}$ are summarized. 16 references.

696

PILE NEUTRON ABSORPTION CROSS SECTION OF SOME OF THE ELEMENTS. F. C. W. Colmer and D. J. Littler. Proc. Phys. Soc. (London) 63A, 1175-6(1950) Oct. 1. (Letter to Editor)

Measurements were made of the neutron absorption cross section of 42 elements with the aid of the pile oscillator in the Graphite Low Energy Experimental Pile at Harwell. A periodically repeated introduction of the sample into the pile, (20 sec in the center of the pile, 20 sec outside the pile), produces a modulation of the pile's power, the depth of the modulation being a function of the total cross section of the sample (see Weinberg et al., Phys. Rev. 74, 851(1948)). The effect of self-screening is avoided by dispersing the sample, e.g., by mixing it with powdered graphite, or by dissolving in heavy water.

697

SPIN ORBIT COUPLING IN THE NUCLEAR SHELL MODEL. J. Hughes and K. J. Le Couteur. Proc. Phys. Soc. (London) 63A, 1219-22(1950) Nov. 1.

It is shown that the magnitude of the doublet splitting postulated in Mayer's nuclear shell model is consistent with that observed in $He^5$. The strength of the indicated spin orbital interaction between pairs of nucleons is worked out. (auth)

698

Carnegie Institute of Technology
TOTAL NEUTRON CROSS SECTIONS OF SEVERAL NUCLEI AT 14 MEV. Albert H. Lasday. Sept. 10, 1950. 93p. (NP-1845; Technical Report No. 7)

Several total neutron cross sections were obtained from a good-geometry transmission measurement using neutrons produced by bombardment of a beryllium target by 15-Mev cyclotron-produced deuterons. Neutrons in the energy range 13 to 15 Mev (13.9-Mev mean energy) were detected by allowing the neutron beam to impinge on a polyethylene radiator and then detecting recoil protons by passing them through a proportional counter telescope. With a small correction for elastic scattering included, the following total neutron cross sections (in barns) were obtained: hydrogen, 0.77 ± 0.04 (from polyethylene and carbon cross sections); beryllium, 1.41 ± 0.11; carbon, 1.24 ± 0.06; titanium, 2.24 ± 0.29; vanadium, 2.52 ± 0.24; zirconium, 2.37 ± 0.35; and lead, 4.97 ± 0.27. The zirconium and lead values are anomalously small, indicating the effect of closed shell structure of the nuclei $Zr^{90}$ (48% abundant isotope) and $Pb^{208}$ (52% abundant isotope). (auth)

## NUCLEAR REACTORS

699

NEPA Division
CONDITIONS FOR CRITICALITY IN CERTAIN TYPES OF NUCLEAR REACTORS. D. S. Selengut. Sept. 28, 1950. 34p. (AECD-3024; NEPA-1581)

The integro-differential equation describing the diffusion of neutrons in a multiplying medium is studied under the assumption of plane geometry and linearly anisotropic scattering, but without the usual limitation to continuous slowing down and weak absorption. Under the condition that the integrated flux vanishes at the boundary, it is shown that a separable solution exists. The relation between core size and the number of neutrons required per fission for a steady state is determined. The results are specialized to the case of isotropic scattering in the laboratory system, and to the case of a medium containing hydrogen and an element which scatters without energy loss. (auth)

700

ATOMIC RESEARCH FOR PEACE. Refrig. Eng., 1064-65, 1114(1950) Nov.

The Brookhaven reactor consists essentially of five elements: moderator (graphite), fuel (uranium), control system, protection shield, and cooling system. This cooling system and the many air-conditioning and refrigeration applications in the various laboratories at Brookhaven are of particular interest to refrigerating engineers. Altogether there will be about 2000 tons of refrigerating apparatus used when the laboratory is in full operation. A description of the reactor is given with special reference to the 300,000 cu ft of air per minute and 9000 gallons of water per minute used for heat transfer and cooling.

## NUCLEAR TRANSFORMATION

701

Argonne National Laboratory and University of Wisconsin
PHOTONEUTRON THRESHOLDS OF BERYLLIUM AND DEUTERIUM. R. C. Mobley and R. A. Laubenstein. June 8, 1950. 21p. (ANL-4468)

The photoneutron thresholds of beryllium and deuterium have been measured by comparison with the $Li^7(p,n)$ threshold. For this purpose an electrostatic generator was used in which an electron beam and a positive ion beam were established simultaneously. Accurate control and measurement of the generator voltage were obtained by using an electrostatic analyzer on the $H_2^+$ component of the ion beam. Because the $Li^7(p,n)$ threshold lies between the $Be^9(\gamma,n)$ and $D(\gamma,n)$ thresholds, errors in extrapolation should be small. The electron beam was accelerated from ground to the accurately known potential of the high-voltage electrode where x rays were produced for the photodisintegration process. From the photoneutron thresholds the neutron binding energies of beryllium and deuterium were found to be 1.666 ± 0.002 and 2.226 ± 0.003 Mev, respectively. (auth)

702

University of California Radiation Laboratory
FAST PROTONS FROM $\pi^-$ MESON ABSORPTIONS IN PHOTOGRAPHIC EMULSIONS. (abstract) F. L. Adelman. Oct. 31, 1950. 1p. (UCRL-980)

The report is reproduced here in its entirety.

The spectrum of fast protons from 1631 $\pi^-$-meson absorptions in Ilford G-5 and C-2 emulsions has been studied. Protons of energy >30 Mev were found to accompany 9.5 ± 1.3% of all $\pi^-$ absorptions, in agreement with other workers (Cheston and Goldfarb, Phys. Rev. 78, 683(1950); Menon et al., Phil. Mag. 41, 583(1950)). The proton energies were estimated by grain counting in comparison with $\pi^-$ mesons of known residual range. Allowance was made for variation of grain density with position and depth in the emulsion. The energy spectrum is fairly flat from 30 to 70 Mev, but only three events were found above 70 Mev. Examination of stars from which the fast protons were emitted shows more prongs ejected opposite to the direction of the fast proton than are accounted for by evaporation from a recoiling nucleus. The evidence suggests that the meson is captured by a proton, and that the resultant neutron recoils against a small, variable number of nucleons; the low-energy star prongs apparently result from knock-on collisions of these nucleons with other nucleons inside the nucleus. Comparison is made between other theories and the experimental results.

703

$\gamma$-RADIATION FROM THE RESONANT CAPTURE OF PROTONS BY $Li^7$ NUCLEI. S. Devons and G. R. Lindsey. Proc. Phys. Soc. (London) 63A, 1202-07(1950) Nov. 1.

Further measurements have been made of the angular distribution of the $\gamma$ radiation in the reaction $Li^7(p,\gamma)Be^8$ (see Devons and Hine, Proc. Roy. Soc. (London) 199A, 56, 73 (1949)). The results indicate approximate isotropy, at resonance, for both spectral components (17.6 and 14.8 Mev) of the radiation. The difficulties in reconciling the properties of the $\gamma$ radiation with results of recent experiments on the scattering of protons by lithium are discussed. (auth)

704

GROUND STATE $^8$Be NUCLEI IN PHOTO-DISINTEGRATION STARS. J. J. Wilkins and F. K. Goward. Proc. Phys. Soc. (London) 63A, 1173-4(1950) Oct. 1. (Letter to editor)

As shown by the authors (Goward et al., Proc. Phys. Soc. (London) 63A, 402, 1171(1950)), photodisintegrations $C^{12} \rightarrow 3He^4$ and $O^{16} \rightarrow 4He^4$, produced by 23 to 25-Mev bremsstrahlung, involve the formation of $Be^8$ as an intermediate product. The shape of the stars is discussed here, and mention is made of another disintegration observed, viz., $B^{11} \rightarrow H^3 + Be^8$. The search for the reaction $N^{14} \rightarrow Li^6 + 2He^4$ has not been successful so far.

705

THE HIGH ENERGY NEUTRONS FROM THE DISINTEGRATION OF $C^{13}$ BY DEUTERONS. J. E. Richardson. Phys. Rev. 80, 850-2(1950) Dec. 1.

An excitation curve for the 5-Mev neutrons resulting from $C^{13}$ bombarded by deuterons has been obtained for neutrons emitted at 0 ± 28 deg to the direction of the deuteron beam. The curve covers deuteron energies from 200 kev to 2.1 Mev. Resonances in the yield were observed at deuteron energies of 0.6, 0.9, 1.55, and 1.80 Mev with half widths of 0.1, 0.4, 0.1, and 0.5 Mev, respectively. These correspond to excited states in the intermediate $N^{15}$ nucleus of 16.7, 16.9, 17.47, and 17.69 Mev. (auth)

706

THE PHOTO-DISINTEGRATION OF OXYGEN INTO FOUR ALPHA-PARTICLES. F. K. Goward and J. J. Wilkins. Proc. Phys. Soc. (London) 63A, 1171-2(1950) Oct. 1. (Letter to editor)

The mechanism of photodisintegrations $O^{16} \rightarrow 4He^4$ in photographic emulsions, previously observed by the authors (Proc. Phys. Soc. (London) 62A, 460(1949)), was investigated on about 100 stars produced by 23- and 25-Mev bremsstrahlung. Approximately one-half of the stars were probably formed via reactions $O^{16} + h\nu \rightarrow C^{12*} + He^4$ (with the 9.7-Mev level of $C^{12*}$) and $C^{12*} \rightarrow Be^8 + He^4$. The remainder of the stars observed involved probably $O^{16} + h\nu \rightarrow C^{12*} + He^4$ and $C^{12*} \rightarrow Be^{8*} + He^4$, with excited levels not yet identified.

707

PROTON GROUPS FROM THE $N^{14}(d,p)N^{15}$ AND $N^{15}(d,p)N^{16}$ REACTIONS. Robert Malm and W. W. Buechner. Phys. Rev. 80, 771-4(1950) Dec. 1.

The proton groups from nitrogen targets [tantalum nitride on tantalum] bombarded with deuterons have been investigated with a magnetic spectrometer. Seven groups have been identified as arising from the $N^{14}(d,p)N^{15}$ reaction with Q values of 8.615 ± 0.010; 3.339 ± 0.005; 3.310 ± 0.005; 2.287 ± 0.005; 1.451 ± 0.005; 1.306 ± 0.005; and 0.300 ± 0.005. One group has been found which is assigned to $N^{15}(d,p)N^{16}$ with Q = 0.034 ± 0.005 Mev. (auth)

## PARTICLE ACCELERATORS

708

University of California Radiation Laboratory
A THICK TARGET FOR SYNCHROTRONS AND BETATRONS. E. M. McMillan. Sept. 19, 1950. 7p. (UCRL-919)

If a wide x-ray beam from an electron synchrotron or betatron is desired, in radiographic work with large objects for example, the usually very thin target may be replaced by a thick one, provided the resulting distortion of the x-ray spectrum due to multiple radiative processes is permissible. It is difficult to make the circulating electron beam traverse a thick target directly because of the small spacing between successive turns. Mounting a very thin beryllium (or other low-Z material) fin on the edge of the thick target so that the fin projects into the beam will cause the beam to lose sufficient energy, and therefore radius, to strike the thick target the next time around. Sample design calculations are given.

709

Ohio State Research Foundation
FINAL REPORT; THE OHIO STATE VAN DE GRAAFF GENERATOR PROGRAM. John N. Cooper. Sept. 30, 1950. 49p. (NP-1781; Technical Report No. 2)

The Van de Graaff generator at Ohio State University is of the horizontal pressure-insulated type. The generator involves no radical departures in design from previous horizontal generators. The general features of the machine and its operation are discussed briefly (Technical Report No. 1, issued in June 1939). At atmospheric pressure with dry air the generator will hold a voltage between 400 and 500 kv before sparking over to the tank wall. The maximum cap voltage increases almost linearly with pressure up to approximately 1.6 million volts. Carbon dioxide appears to have slightly better dielectric properties than air and has the added advantage that it will not support combustion. Most of the data taken with this generator have been obtained with a mixture of dry air and carbon dioxide in the pressure tank. Thin lithium fluoride targets were prepared by evaporation and these targets were bombarded by the proton beam and by the ionized molecular hydrogen beam. Data taken with a lithium fluoride target are presented. Proton bombardment of phosphorus and of magnesium are described. 16 references.

## RADIATION ABSORPTION AND SCATTERING

710

University of California Radiation Laboratory
HIGH ENERGY NUCLEON-NUCLEON SCATTERING EXPERIMENTS AT BERKELEY. Geoffrey F. Chew and Burton J. Moyer. Aug. 3, 1950. 29p. (UCRL-756)

Results of experiments concerning neutron-proton scattering, proportional counter measurements with 90- and 40-Mev neutrons, cloud chamber measurements with 90-Mev neutrons, neutron-proton measurements, proton-proton scattering, counter measurements with protons from the linear accelerator, photographic plate measurements with protons from the linear accelerator, and counter measurements with 350-Mev protons from the synchrocyclotron are discussed. It is indicated that the most widely shared opinion about nuclear forces at present is that they are due to the exchange of mesons between nucleons but that so many mesons are involved, at least in situations so far considered experimentally, that the over-all effect is complicated and cannot be used as the starting point in making a theory. Attention is now turning to the mesons themselves in the hope that they will behave more simply than the nucleons which they so profoundly influence. 11 references.

711

Case Institute of Technology
DIFFUSION OF HIGH-ENERGY GAMMA RAYS THROUGH MATTER; PART I. FUNDAMENTAL EQUATIONS. L. L. Foldy. Aug. 7, 1950. 19p. (NP-1809; Technical Report No. 3)

The fundamental processes of photoelectric absorption, Compton scattering, and pair production leading to the modification of the energy spectrum and angular distribution of $\gamma$ rays diffusing through matter are discussed in relation to the problem of penetration of $\gamma$ rays through matter. The transport equation describing the diffusion is derived in the approximation in which radiation from the secondary electrons produced by the photoelectric effect and pair production is neglected. By limiting one's interest to $\gamma$ rays of energy greater than a few Mev, further approximations may be made which reduce the transport equation to a much more simple form. An elementary proof is given for the following theorem: If monoenergetic $\gamma$ rays are incident normally on a slab of material, then after the $\gamma$ rays have undergone many Compton scatterings, the $\gamma$ rays of a given energy are distributed Gaussian-wise in angle about their original direction with the breadth of the distribution being simply related to the energy and increasing with decreasing energy. (auth)

712

Case Institute of Technology
DIFFUSION OF HIGH-ENERGY GAMMA RAYS THROUGH MATTER; PART II. SOLUTION OF THE DIFFUSION EQUATION. L. L. Foldy and R. K. Osborn. Aug. 10, 1950. 18p. (NP-1810; Technical Report No. 4)

An approximate solution of the diffusion equation derived in Part I (see NP-1809) has been obtained for the case in which

the total $\gamma$-ray cross section is independent of energy. This is the case for essentially all materials in the energy region in which the derived diffusion equation is valid. For monoenergetic $\gamma$ rays incident normally on a slab of material, the distribution in angle of $\gamma$ rays of a given energy after traversing a large thickness of material is shown to be Gaussian with a breadth depending on the energy in accordance with a theorem derived in Part I. Some numerical calculations for the case of 17-Mev $\gamma$ rays incident on water are presented to illustrate the nature of the results. 3 figures. (auth)

713

THE HARD COMPONENTS OF SCATTERED GAMMA-RAYS. P. B. Moon. Proc. Phys. Soc. (London) 63A, 1189-96(1950) Nov. 1.

A summary is given of theoretical information on the three processes by which $\gamma$ rays can be elastically scattered by atoms, viz., Rayleigh scattering by bound electrons, Thomson scattering by the nuclear charge and (exceptionally) nuclear resonant scattering. Interference between the three scattered waves is considered and shown to be of practical importance as between Rayleigh and Thomson scattering of hard $\gamma$ rays at large angles. The calculated intensities of Rayleigh, Thomson, and Compton scattering are plotted against angle of scattering for $\gamma$-ray energies of 2.8 and 0.41 Mev, and for scatterers of Al, Cu, and Pb. The graphs illustrate the dominance of Rayleigh scattering at very small angles for all energies, and the comparable intensities of Rayleigh and Thomson scattering at high energies and large angles. The unidentified hard component found by Pollard and Alburger (Phys. Rev. 74, 926(1948)) in the large-angle scattering of 2.8-Mev $\gamma$ rays by various elements is interpreted as a mixture of Rayleigh and Thomson scattering; theoretical and experimental intensities show reasonable agreement for both light (Al) and heavy (Pb) scatterers. Experiments on the scattering of 0.41-Mev $\gamma$ rays at about 115 deg are reported. In agreement with theory, about 2% of the radiation scattered from Pb is found to retain the full energy; for Cu and Al, the proportion of elastically scattered photons is much smaller. (auth)

714

Princeton University
THE SCATTERING OF POSITRONS AND ELECTRONS BY NUCLEI. H. J. Lipkin. July 1950. 78p. (NP-1822; Technical Report No. III)

The scattering at 57.9 deg of 1-Mev electrons and positrons by thin foils has been investigated experimentally from two points of view: (1) to compare the cross section for elastic nuclear scattering of positrons with that of electrons, and (2) to look for inelastically scattered electrons which have suffered large energy losses. The first is of interest because theory predicts a large difference between positron and electron nuclear scattering resulting from spin-orbit coupling. The second is of interest because there have been many experimental reports of such inelastic scattering but no satisfactory theoretical reason for the effect. The experiment was performed by allowing $\beta$ particles emitted from a radioactive source to pass through a solenoid-type $\beta$-ray spectrograph and be focused on a scattering foil. Those particles scattered by angles near 57.9 deg passed through a transverse analyzing magnetic field into a Geiger counter. To study the elastic scattering, sources of electrons and positrons were consecutively inserted into the apparatus, and the counting rates of scattered particles were measured and compared. To study inelastic scattering, spectra were taken with the analyzer magnet to determine the energy distribution of the scattered particles. Values were obtained for the ratio of the electron-scattering cross section to that of positrons at three different energies in the 1-Mev region for foils of platinum and copper. The results were in rough agreement with theoretical predictions, with a consistent deviation which may be attributed to the failure of the theory to include the effects of screening. The investigation of inelastic scattering failed to observe any effect in foils of Al, Cu, Pt, or Pb. (auth)

## RADIATION EFFECTS

715

CHANGES IN CONDUCTIVITY OF GERMANIUM INDUCED BY ALPHA-PARTICLE BOMBARDMENT. W. H. Brattain and G. L. Pearson. Phys. Rev. 80, 846-50(1950) Dec. 1.

The bombardment of n-type germanium by $\alpha$ particles from polonium first removes the conducting electrons at the rate of 78 per $\alpha$ particle. After the electrons are gone, conducting holes are introduced at the initial rate of 8.6 per particle. Some of these holes disappear with time at room temperature after bombardment is stopped, leaving only two conducting holes per particle. This change takes place only to the depth of penetration of the particles, namely, $1.9 \times 10^{-3}$ cm. The distribution of holes with depth is not uniform. The concentration rises from an initial value to a maximum at $1.4 \times 10^{-3}$ cm depth and then falls to zero. The maximum is about 2.5 times the initial value and the integral under the curve is, of course, two holes per particle. (auth)

## RADIOACTIVITY

716

University of California Radiation Laboratory
THE NEW ISOTOPE $Pu^{242}$, AND ADDITIONAL INFORMATION ON OTHER PLUTONIUM ISOTOPES. S. G. Thompson, K. Street, Jr., A. Ghiorso, and F. L. Reynolds. June 23, 1950. Decl. Oct. 11, 1950. 5p. (AECD-2993; UCRL-657)

Investigation of the higher isotopes of plutonium produced by intensive neutron irradiation of $Pu^{239}$ and $Am^{241}$ samples over periods up to a few years has revealed the existence and properties of a new isotope, $Pu^{242}$, and has yielded some additional information about $Pu^{240}$ and $Pu^{241}$. The $\alpha$-particle energy of $Pu^{240}$ does not differ by more than ~20 kev from that of $Pu^{239}$, and is, therefore, $5.16 \pm 0.02$ Mev. A partial half-life for $\alpha$ decay of $Pu^{241}$ of roughly $4 \times 10^5$ yr and a half-life for $\beta$ decay of 14 yr were obtained, and a rough estimate of 250 barns for the reaction $Pu^{241}(n,\gamma)Pu^{242}$ was made. $Pu^{242}$ was obtained from the electron-capture branch of $Am^{242m}$ decay. Pulse analysis of this isotope showed the presence of 4.88-Mev $\alpha$ particles in abundance correspond-

ing to a half-life of roughly $5 \times 10^5$ yr. This energy and half-life agree well with those predicted for $Pu^{242}$ by $\alpha$-decay systematics, which also indicate that this isotope should be $\beta$ stable.

717

Argonne National Laboratory
REPORT ON RADIATIONS OF UY; PPR 17B, NO. 9.30. Arthur H. Jaffey, Jerome Lerner, and Sylvia Warshaw. Feb. 2, 1949. Decl. Dec. 18, 1949. 9p. (AECD-3022; ANL-4247)

$Th^{231}$ (UY) was separated from purified enriched uranium containing about 95% $U^{235}$, and its decay was investigated. The results indicate that the following components are probably present with approximately equal intensity (within perhaps 25%): 0.20-Mev $\beta$, L x rays, M x rays, 50-kev conversion electrons, 35-kev $\gamma$. In addition there seems to be evidence for the existence of a highly converted $\gamma$ in the range 60 to 70 kev and of a low-intensity $\gamma$ with an energy of 100 kev or greater. Despite the scanty evidence, a tentative decay scheme is presented. At zero absorber, using an argon-alcohol mica-window G-M tube, the very soft component (presumably M x rays and conversion electrons) had almost twice as many counts as the $\beta$-ray component; the counting rate of the L x rays was about $\frac{1}{30}$ that of the $\beta$ rays; the 35-kev counting rate was about $\frac{1}{10}$ that of the L x rays; while the counting rates of the other $\gamma$'s were somewhat lower yet. The half-life of UY was measured as $25.6_4 \pm 0.1$ hr.

718

Iowa State College
THE DISINTEGRATION OF $Hf^{181}$. William W. Pratt. [nd.] 4p. (AECU-979)

Coincidences in the radiations from $Hf^{181}$ were studied, using a $\beta$-ray spectrometer and secondary counter. The results indicate that the $\beta$ decay of $Hf^{181}$ leads to the 20 $\mu$sec metastable state in $Ta^{181}$ which then decays via the 130-kev and 471-kev transitions in cascade. The work of Jensen (Phys. Rev. 76, 958(1949)) indicates that the 130-kev transition originates in the metastable state and it is thus concluded that this transition precedes the 471-kev transition.

719

Los Alamos Scientific Laboratory
RADIOACTIVITIES OF $Ru^{105}$, $Rh^{105}$, $Br^{84}$, and $Br^{83}$. R. B. Duffield and L. M. Langer. [nd.] 19p. (AECU-995; LADC-872)

A lens spectrometer was used to study the disintegrations of $Ru^{105}$ (4.5 hr), $Rh^{105}$ (36.2 hr), $Br^{84}$ (32 min), and $Br^{83}$ (2.4 hr). $Ru^{105}$ emits a simple $\beta$ spectrum with an end-point energy of $1.150 \pm 0.006$ Mev. This is followed by a 0.726-Mev $\gamma$ ray to a metastable level in $Rh^{105}$. The decay to the ground state of $Ru^{105}$ proceeds with a $\gamma$ ray of about 0.1 Mev, with a half-life of 45 sec. The ground state of $Rh^{105}$ emits a simple $\beta$ spectrum of $0.570 \pm 0.005$ Mev. No $\gamma$ ray appears to be associated with this decay. $Br^{84}$ emits a complex $\beta$ spectrum which can be resolved into at least four groups with end points and relative intensities of 4.679 Mev (40%), 3.56 Mev (9%), 2.53 Mev (16%), and 1.72 Mev (35%). The 4.679-Mev group, which goes directly to the ground state of $Kr^{84}$, does not have a forbidden spectrum shape. It is suggested that the 32-min half life may be associated with an isomeric level above the ground state of $Br^{84}$. The decay of $Br^{83}$ consists of a single $\beta$-ray group with a maximum energy of $0.940 \pm 0.010$ Mev. (auth)

720

Argonne National Laboratory
RADIATIONS FROM 120-DAY $Ta^{182}$. D. W. Engelkemeir, M. S. Freedman, and Jack May. June 20, 1950. 16p. (ANL-4473)

Absorption and coincidence experiments have been carried out to determine the number of hard $\gamma$'s per disintegration of $Ta^{182}$ and, if possible, their place in the disintegration scheme of this isotope. A survey of the literature combined with this new work indicates that the radiations from $Ta^{182}$ consist chiefly of the following:

| Radiation | Energy | Approximate number per disintegration |
|---|---|---|
| $\beta^-$ | 0.53 Mev | 1.0 |
| $e^-$ | At least 36 lines from 0.030 to 0.259 Mev | 1-2 total |
| Soft $\gamma$'s | At least 14 lines from 0.046 to 0.262 Mev | 1-2 total |
| $\gamma$ | 1.121 | 0.4 |
| $\gamma$ | 1.188 | 0.2 |
| $\gamma$ | 1.224 | 0.4 |

A decay scheme, probably correct in its general outline but incorrect or incomplete in some details, is presented. 9 figures.

721

University of California Radiation Laboratory
ELEMENT 98. S. G. Thompson, K. Street, Jr., and A. Ghiorso, G. T. Seaborg. Feb. 27, 1950. 3p. (UCRL-619)

A short report, as of February 1950, announces the identification of californium $Cf^{244}$ through the irradiation of $Cm^{242}$ with 35-Mev helium ions. The half-life is ~45 min, decay being by emission of ~7.1-Mev $\alpha$ particles. Chemical separation and identification were accomplished through use of ion exchange absorption methods. The tripositive oxidation state was the only one identified. No further details are given.

722

University of California Radiation Laboratory
POLONIUM ISOTOPES PRODUCED WITH HIGH ENERGY PARTICLES. D. G. Karraker and D. H. Templeton. Sept. 25, 1950. 35p. (UCRL-640(Rev.))

Four new isotopes of Po produced from Bi and Pb by high-energy spallation have been investigated, and their decay products, which include three new Pb and Bi activities, have been studied. The mass assignments are made by the identification of known activities as decay products. Some of the properties of these new isotopes are as follows:

| Isotope | Half-life | Mode of decay | Energy in Mev |
|---|---|---|---|
| $Po^{205}$ | 1.5 hr | EC, $\alpha$ | $5.22 \pm 0.10$ ($\alpha$) |
| $Po^{204}$ | 3.8 hr | EC, $\alpha$ | $5.37 \pm 0.02$ ($\alpha$) |
| $Po^{203}$ | 47 min | EC | |

| Isotope | Half-life | Mode of decay | Energy in Mev |
|---|---|---|---|
| $Po^{202}$ | 52 min | EC, $\alpha$ | 5.59 ± 0.03 ($\alpha$) |
| $Bi^{205}$ | 14.5 days | EC | 0.431, 0.527 0.550, 0.746 ($\gamma$) 1.84 |
| $Bi^{202}$ | 95 min | EC | |
| $Pb^{198}$ | 25 min | EC | |

723

University of California Radiation Laboratory
ON THE HALF-LIFE OF ACTINIUM. J. M. Hollander and R. F. Leininger. Sept. 5, 1950. 6p. (UCRL-894)

The decay of a sample of actinium separated from pile-irradiated radium in 1947, and therefore in secular equilibrium with its daughter products, has been followed using the differential ionization chamber described by Segrè and Wiegand (Phys. Rev. 75, 39(1949)). From the data, the half-life of $Ac^{227}$ was calculated to be 22.0 ± 0.3 yr.

724

University of California Radiation Laboratory
DELAYED EMISSION OF NEUTRONS FROM LIGHT ELEMENTS. (abstract) William Gardner, N. Knable, and B. J. Moyer. Nov. 8, 1950. 1p. (UCRL-1000)

The report is reproduced here in its entirety.

In addition to the delayed neutrons appearing with a 4.17-sec half-life from the decay of $N^{17}$ previously identified at Berkeley, a 0.165-sec emission has been discovered. It has been obtained, at the time of this writing, by 190-Mev deuteron bombardment of $Be_2N_3$ and elemental boron. Observations are made by rapidly moving film exposures of an oscilloscope screen displaying a scaled output of $BF_3$ chamber pulses. The results of attempts to identify the neutron emitter and the parent $\beta$ decay will be presented.

725

BETA AND GAMMA RADIATION. I. ORIGIN AND PROPERTIES OF $\beta$-RADIATION. J. V. Jelley. Atomics (London) 1, 313-18(1950) Nov.

In the first of the series, $\beta$ radiation is discussed exclusively. Nuclear dimensions and structure, origin of $\beta$ radiation, instability and half-life, $\beta$ radiation from the neutron, $\beta$ radiation with emission of positive electrons, the energy of the emitted beta particles and the neutrino, and the life-history of a $\beta$ particle are considered in simple terms.

726

FORBIDDEN $\beta$ DECAY IN $Na^{24}$. P. J. Grant. Proc. Phys. Soc. (London) 63A, 1298-9(1950) Nov. 1. (Letter to editor)
In the well-established decay scheme of $Na^{24}$ there is a $\beta$ transition to the 4.14-Mev level of $Mg^{24}$, followed in cascade by two $\gamma$ transitions, viz., to the 1.38-Mev level and the ground state of $Mg^{24}$. In view of the larger energy release in the hypothetical $\beta$ decays $Na^{24} \rightarrow Mg^{24*}$(1.38 Mev) or $Na^{24} \rightarrow Mg^{24}$(ground state), a search was made for electrons belonging to either of these spectra. The only result has been to place an upper limit on the probability of occurence of these processes. The ratio of the ft values showed that a spectrum of the transition to the 1.38-Mev level must be at least 3 deg more forbidden than the known spectrum (to the 4.14-Mev level). This low transition probability can be tentatively explained by appropriate spin and parity assignments; however, if the latter are not confirmed by future measurements, the presence of some other factors capable of reducing the transition probability will be established.

727

SOME DISINTEGRATION DIAGRAMS DETERMINED BY THE COINCIDENCE METHOD. G. A. Renard. Ann. phys. 5, 385-450(1950) July-Aug. (In French)

Radioactivities of $V^{52}$ and $Au^{198}$ were studied using coincidence methods. $V^{52}$ emits soft electrons independent from the $\beta$ radiation. Their origin is explained by assuming a 2.55 min isomeric transition whose $\gamma$ ray, of 250-kev energy, is entirely converted. The $\beta^-$ emission of $Au^{198}$ has probably a simple spectrum with a 0.95-Mev energy maximum, and is followed by a 5%-converted 0.4-Mev quantum. Techniques and theory of measurement are discussed in some detail.

## RARE EARTHS AND RARE-EARTH COMPOUNDS

728

THE MAGNETIC SUSCEPTIBILITY OF EUROPIUM AND SAMARIUM AMALGAM. David L. Douglas and Don M. Yost. J. Chem. Phys. 18, 1418-19(1950) Oct. (Letter to the editor)

The magnetochemical properties of amalgams offer a promising approach to the study of rare-earth metals. Some preliminary studies are reported. Samarium and europium were chosen as the first objects of study because of the considerable theoretical importance attached to their position near the middle of the lanthanide series. The amalgams were prepared by reducing the rare-earth acetates in solution with sodium amalgam. The susceptibilities were measured by the Gouy method. The susceptibility found for europium amalgam agrees with that found for metallic europium, but the value for samarium amalgam is much greater than that for the metal. The reason for this anomaly is not known.

## SHIELDING

729

H. K. Ferguson Company, Inc.
... HEAT TESTING OF HIGH-DENSITY CONCRETE. C. R. Binner, C. B. Wilkie, and Philip Miller. June 1, 1949. 3p. (AECD-3001; HKF-1 Suppl.)

The results of tests to determine the effect of heat on the compressive strength and moisture content of the high-density concrete used in shielding are reported. This report is a supplement to HKF-1.

730

Battelle Memorial Institute
INVESTIGATION OF CEMENTITIOUS MATERIALS FOR POSSIBLE USE IN CONCRETES FOR PILE SHIELDING. M. J. Snyder, C. A. Burkart, and J. W. Clegg. Sept. 1949. 20p. (AECD-3004; BMI-T-21)

The experimental program on concretes for pile shielding reported herein has been concerned with the development of highly hydrated concretes of high density with acceptable mechanical properties. Cements were prepared containing appreciable percentages of two or more of the following elements in chemical combination: H, C, O, Mg, Al, Si, P, S, Cl, Ca, V, Cr, Mn, Co, Ni, Cu, Zn, Cd, Sn, Ba, Hg, and Pb. Of the various cements prepared from these elements, only litharge-glycerin cement had a higher water content than magnesium oxychloride cement. Many of the cements had a higher specific gravity than magnesium oxychloride cement (1.92); cupric phosphate, lead phosphate, litharge-glycerin, and barium aluminum silicate cements all had specific gravities greater than 3.0. Considerable development work would be necessary to permit utilization of most of the cements in large-scale operations owing to their short setting times. The barium-containing Portland-type cements and litharge-glycerin cements appeared to be most promising for this additional development. A number of salts were found to yield acceptable cements when their solutions were mixed with magnesia. The resultant cements resembled magnesium oxychloride cements in many ways, but, in general, were inferior to the oxychloride cement in most respects. Exploratory investigations of mixtures of various oxides and salt solutions revealed several systems which merited additional study. (auth)

731

Battelle Memorial Institute
MAGNESIUM OXYCHLORIDE CEMENTS AND CONCRETES FOR PILE SHIELDING. M. J. Snyder and A. E. Pavlish. Aug. 1949. Decl. Nov. 9, 1950. 46p. (AECD-3005; BMI-T-15)

Highly hydrated concretes of high density and satisfactory mechanical properties were obtained through the use of magnesium oxychloride cements and iron-shot aggregate. The grade of magnesia, the concentration of the magnesium chloride solution, and the addition of set cement influenced the water content, strength, stability on storage, and resistance to elevated temperatures of the magnesium oxychloride concrete. A magnesium chloride concentration of about 26° Bé produced concretes having superior stability and temperature resistance. The results of the work reported show the marked importance of the raw materials used on the stability of the resultant cements. This factor is of practical importance if these highly hydrated cements are to be used in shielding applications. Stabilization of magnesia cements can be effected by appropriate minor additions such as phosphates.

732

Battelle Memorial Institute
CONCRETES FOR PILE SHIELDING. A. E. Pavlish and J. C. Wynd. Aug. 1948. Decl. Nov. 9, 1950. 27p. (AECD-3007; BMI-T-4)

Highly hydrated concretes having high density and satisfactory mechanical properties are desired for pile shielding. Cements having a wide range of water contents have been investigated. The highest water contents were obtained on magnesium oxychloride cements. Water contents as high as about 0.9 g/cc were obtained. This value was more than twice that obtained on ordinary Portland cement. Cements prepared with magnesia as a base were uniformly high in water content. The magnesium oxysulfate cements were slightly lower in water content than the oxychloride. Cements prepared from tricalcium pentaluminate approached the magnesium cements in water content. The addition of calcium sulfate to Lumnite cement increased the water content of the cement appreciably. All the cements reported had water contents greater than ordinary Portland cement. A study of methods of attaining high-density concretes resulted in iron-bearing concretes of satisfactory strength and workability with densities of around 5.7 g/cc. The high-density concretes employed an aggregate composed of a specific mixture of coarse and fine iron shot.

## SPECTROSCOPY

733

ANALYSIS OF THE SPECTRUM OF DOUBLY IONIZED THORIUM, Th III. P. F. A. Klinkenberg. Physica 16, 618-50(1950) July-Aug.

The analysis of the Th III spectrum is revised and extended to include 314 lines as transitions between 39 even and 40 odd levels arranged in two-term systems. All configurations are completed. The configurations 6d7p and 5f7p show pronounced jj coupling. The lowest levels of the two-term systems do not differ more than a few 1000 $cm^{-1}$ in energy. Evidence is obtained that $5f^6d\ ^3H_4$ is 809.9 $cm^{-1}$ above $6d^2\ ^3F_2$; the latter is the ground state of Th III. A complete list of all observed lines attributed to Th III is given. Remarkable Stark shifts are shown by the Th III lines both in value and in direction, depending on the related configurations. A new group of Th III lines is discovered in the ultraviolet region below 3300 A. These lines are considered as combinations of unknown high levels with the intermediate configurations. It is shown that this interpretation is consistent with a reasonable value for the ionization potential, which is provisionally determined at 161,000 $cm^{-1}$ or 19.9 volts.

734

ON THE SPECTRUM OF Th III. Giulio Racah. Physica 16, 651-66(1950) July-Aug.

The levels of Th III are compared with the theoretical formulas for intermediate coupling with configuration interaction. The agreement is very satisfactory. Also, the circulated g values generally agree with the experimental data. (auth)

## THEORETICAL PHYSICS

735

Los Alamos Scientific Laboratory
ON THE MANY-BODY PROBLEMS WITH OSCILLATOR POTENTIALS. Conrad Longmire. [nd.] 2p. (AECU-993; LADC-780)

The note points out that the Schroedinger equation can be solved for the case of N particles of equal mass which act on each other with equal harmonic oscillator potentials.

736

Nuclear Development Associates, Inc.
THE TRANSPORT EQUATION IN THE STRAIGHT AHEAD CASE. J. Ernest Wilkins, Jr., Alan Oppenheim, and Leonard Solon. Sept. 1, 1950. 32p. (NYO-633)

Solutions to the Laplace-transformed integral equation are presented for the cases of factorable (separable) K(t,E) kernel, separable kernel with a stepwise Greuling condition, and kernel of elementary type (expressible as a sum of products). The problem of solving the transport equation directly is attacked by various series expansions.

737

INVESTIGATION OF THE FOUNDATIONS OF THE QUANTUM PROBABILITY THEORY (HILBERT SPACE AND UNDULATION PRINCIPLE). Georges Bodiou. Ann. Phys. 5, 451-536(1950) July-Aug. (In French)

An attempt is made to found wave mechanics on a critical study of the use of probability calculus in physical theory. Classical structures of stochastic dependences are unable to embrace such important concepts of the theory as probability interferences. The problem can be solved if stochastic relationships are introduced by means of the Hilbert space. This is done in an analysis of disjunctive judgments a posteriori of the type "$a_1$ or $a_2$," by replacing the absolute disjunction by a moderate one (the operation being similar to the replacement of absolute simultaneities by statements of facts concerning light signals). When applied to conjugate coordinates and momenta, this picture of stochastic dependences shows the necessity of a postulate on the Gaussian character of probability densities, a postulate equivalent to the undulation principle.

738

NON-LINEAR INTERACTIONS BETWEEN ELECTROMAGNETIC FIELDS. Robert Karplus and Maurice Neuman. Phys. Rev. 80, 380-5(1950) Nov. 1.

The covariant S-matrix formalism of Dyson has been applied to the calculation of the fourth order nonlinear polarization of the vacuum, which is related to the lowest order nonlinear interaction between electromagnetic fields. The finiteness and the gauge invariance of the interaction are exhibited explicitly by an expression for the fourth-rank vacuum polarization tensor in momentum space. (auth)

739

ON THE CONSTRUCTION OF AN INVARIANT QUANTUM FIELD THEORY. N. N. Bogolyubov, V. L. Bonch-Bruevich, and B. V. Medvedev. Doklady Akad. Nauk S.S.S.R. 74, 681-4 (1950) Oct. 1. (In Russian)

Many unsuccessful attempts have been made at constructing a relativistically invariant quantum field theory in which the invariance would not be illusory, or in which freedom from physically absurd consequences would not be obtained by means of an artificial "subtractive formalism." In this work an investigation is made of conditions imposed on any quantum field theory by the invariance requirement. Those conditions are written as permutational relationships whose analysis, in the frame of the classical theory, has recently been made by Dirac (Revs. Modern Phys. 21, 392(1949)). The equations obtained give all forms of Hamiltonians possible in the relativistic theory.

740

SINGULAR POTENTIALS. K. M. Case. Phys. Rev. 80, 797-806(1950) Dec. 1.

The difficulties arising in quantum mechanics when the potential is highly singular are considered. It is found that the Hamiltonian needs further specification in such cases. This may be done conveniently by requiring a fixed phase for the wave functions at the origin. A proof that all the well-known singular examples are amenable to this treatment is given. For illustration the spectra for spin zero and one-half particles in the fields of highly charged nuclei are found. It is also shown that a complete set of eigenfunctions for a vector particle in a Coulomb field can be found. (auth)